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AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

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Improved Iron Planer.

The planer which we illustrate herewith is one made by the Fitchburg Machine Works, Fitchburg, Mass. It is a heavy machine, made from new designs, so proportioned as to secure strength and durability. It will plane 36″×36″×12 feet. It has two heads on cross beam, each provided with independent power, down, cross, and angular feed, also power attachment for raising and lowering cross beam. This makes it a very desirable machine for many kinds of work where two tools can be used at once, nearly doubling the work done. The strength of this machine is ample for two tools. An ingenious attachment is used for holding the cross beam firmly to the upright posts; by the use of this attachment much time is saved in adjusting the cross beam to any desired height, as it does away with the necessity of loosening and tightening four screws on back side of the beam each time it is required to be raised or lowered.

All the gears and racks are cut, handles and balances are made of wrought-iron, driving shaft and screws are made of steel. The fits to beam and crossheads are scraped. The table is scraped to the Vs on bed. Quick return motion to the table. If desired, can be furnished with an attachment for feeding cross beam down.

Surface Indications of Natural Gas.

The following statement in regard to "surface indications" of natural gas deposits is made by Professor Leslie touching Pennsylvania. In answer to the question, "Shall I bore for gas at my works?" he says:

"First of all—There can be no gas stored up in the oldest rocks. This settles the question in the negative for the whole south-eastern third of Pennsylvania. To bore for gas in Bucks, Philadelphia or Delaware counties, would be simply absurd.

"Second—There can be no gas left underground where the old rocks have been turned up on edge and overturned, fractured and re-cemented, faulted and disturbed in a thousand ways. If there ever was any, it has long since found innumerable ways of escape into the atmosphere. This settles the question for all the counties of the great valley, as any one can see by looking at the present condition of their limestone, slate and sandstone formations.

"Third—There is not the least chance that any gas is left underground in the greatly folded, crushed and hardened formations of the middle belt of the State. Where the oil and gas rocks rise to the surface in these counties, they show that all their oil and gas have escaped long ago.

"Fourth—Where the rock formations lie approximately horizontal, and have remained nearly undisturbed over extensive areas, in all the counties west of the Alleghenies, there is always a chance of finding gas, if not oil, at some depth beneath the surface, determined by the particular formation which appears at the surface.

"Fifth—Wherever the bituminous coal beds have been changed into anthracite or semi-bituminous coal, it is reasonable to suppose that the same agency which produced the change, whatever it was, must have acted on the whole column of formations, including any possible gas rock at any depth.

"Sixth—Wherever rock oil has been found, there and in the surrounding region rock gas is sure to exist."

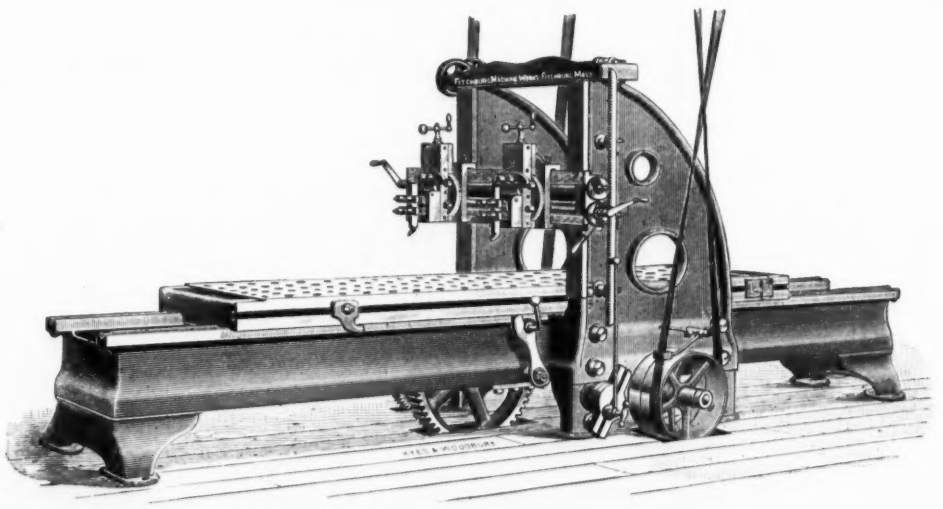
Baughman's Boiler Tube Cutter.

This tool is used for cutting off tubes, for removal, inside the tube sheet, also for cutting tubes to the right length after placing in the boiler and expanding one end. This not only saves time, but avoids the danger of splitting the tubes by the use of a chisel; it also does away with putting in tubes, marking, taking out and cutting to length, as is frequently done; with this cutter, in locomotive practice, for instance, it is necessary only to put in the tubes, expand the ends in the fire box, then cut to length. The gauging being done from the fire-box, the proper distance will be preserved if the surface is uneven.

There appears to be nothing likely to get out of order about this tool; it is made of steel, and hardened. It has three revolving wheel cutters, that cut from the inside. While cutting, the bearing is all on these cutters. In case of renewal the cutters are inexpensive to make. It works easily and rapidly.

It is made in any size required by Pedrick & Ayer, proprietors of the L. B. Flanders Machine Works, Philadelphia, Pa.

The city of Coblenz, Germany, is supplied with water by two 50 horse-power Otto engines, a third engine of the same power being kept in reserve. The city owns and operates their gas works, and it is said that the gas engines are found economical for the purpose. For starting the large engines a two horse-power gas engine is employed; this starts the large engine till a charge of explosive is taken in, when it is automatically disconnected. Gas engines of the same kind—three in number of 50 horse-power each—are used for the electric light plant of the city of Prague, Austria.



IMPROVED IRON PLANER.

Just at this writing the demand for good draughtsmen, who are practical mechanics as well, appears to be greater than the supply. In most instances the draughtsman is wanted only for a few weeks, or months, to tide over some emergency. It looks as if preparations were being made for bringing out more than the usual number of new machines, and this will have an influence in helping along business by making more work in the future.

Notes for Discussion in Relation to the Development of the Compound Engine and the Probable Limit of Steam Pressure in Marine Engines and Boilers.

BY CHAS. E. EMERY, NEW YORK CITY.

A PAPER PRESENTED AT THE WASHINGTON MEETING OF MECHANICAL ENGINEERS.

Fifty years ago, when steam navigation was in its infancy, the steam pressure employed in marine engines was as low as five to ten pounds, but as boiler construction improved, a rapid increase took place to 20 and 25 pounds, until finally a sort of stand-still, at a maxium of about 40 pounds, was established for a series of years.* This pressure was considered so high that compound engines were constructed in which to use it. Some notable examples running on the west coast of South America were familiar to marine engineers some twenty years ago, and curiously enough the reports which came from those engines corresponded closely with the reports from modern engines of certainly better economy, in that it was claimed that the power was obtained with the consumption of one and a half pounds of coal per indicated horse-power per hour. Higher pressures were in vogue on inland waters almost from the commencement of steam navigation on the same, but were introduced much more slowly on sea-going steamers. As improvements in the mechanical arts progressed, it was found that steam boilers could be safely constructed to carry higher pressures, and steam machinery for using steam at a pressure of 60 pounds and more was made from time to time. Engines of the compound type were made at an early date, but did not at first find much favor, and it was not until about the year 1870 that this engine was what may be called reintroduced and established as the marine engine of the future. The initial successes of this period were doubtless made by various constructors in Great Britain, the firm of Elder & Co. being probably in the lead. Mr. Thomas W. Lay, at about the same time, established a certain form of engine of this class on the Great Lakes. The writer also, through opportunities given as Consulting Engineer of the U. S. Coast Survey and Revenue Marine, took an active part in developing the system on the smaller Government vessels—and the information thus obtained, together with that which could be procured from abroad, was utilized by the U. S. naval officers in designs for compound engines for vessels of war.

Meanwhile, the "doubting Thomases" among marine engineers claimed that just as good results could be obtained with single engines of long

* The well-known veteran engineer, Chas. H. Haswell, in response to an inquiry, states, "In 1821, the first year of which I have a clear remembrance of the pressure of steam borne by the low-pressure boilers of the day, the general practice was from 10 to 12 pounds, as the form of boiler then, from the form of the flues and the absence of bracing, would not admit of greater pressure." He however adds, "The Great Western, the second steamer that reached here from England, was operated with steam at 3.5 pounds pressure. Her boilers, the box flue, would not admit of a greater pressure."

stroke, and a number of vessels were built to prove this theory, many of which did very well. The practical work of the compound engines in this country soon, however, had the effect of converting the most earnest advocates of expansion in a single cylinder. Without mentioning names it may be said that one after another the older engineers succumbed to the inevitable, and now the writer does not know of a single one, or a single firm, that adheres to former opinions and prejudices. To-day there are numbers of ocean steamers, both small and large, running with steam pressures as high as 160 pounds to the square inch. The steam is used in triple expansion engines, and the advocates of the system claim as great economy in the change from double to triple expansion as was originally claimed in that from simple engines to the ordinary compound engines. Undoubtedly overstatements are made as great as those formerly made in relation to the ordinary compound engine. The results with the latter should of course have been compared only with those from engines operating with the same steam pressure and under the best conditions for economy at that pressure; whereas they were frequently compared with those from low pressure engines of obsolete type. The performances of the triple compound engines are not only not being compared with those of compound engines operating at the same pressure, but comparisons have been made with the results obtained with engines which have been allowed to run down, and in cases where the boilers have deteriorated so that the pressure originally intended is not maintained.

With the view of settling various questions of this kind in relation to the original compound engine a series of experiments were made in the years 1874 and 1875, under the general direction of Chief Engineer Charles H. Loring, U. S. Navy, representing the Navy Department, and the writer, representing the Treasury Department, with the machinery of various revenue steamers, designed by the writer, one having a compound engine, another a high pressure condensing engine, another a similar engine with a jacket, and another with a low pressure engine.

These experiments showed that at the pressure employed, viz., 70 pounds, the gain due to compounding was only 12 to 15 per cent. as compared with using the steam with an equal degree of expansion in a single cylinder. Official reports of these experiments were made to the Navy and Treasury Departments and the results discussed by the writer in several journals. Abstracts of the reports were also made by various periodicals and embodied in the current literature on the subject.* In the discussion, the writer stated that the average economy of compound engines was doubtless nearer 25 per cent. than 12 to 15, on account of mechanical difficulties incident to keeping in order single engines working at a high degree of expansion and the liability of the engineer to reduce the steam pressure and follow a little further in the stroke to relieve the strains on his joints and all the working parts of the engine and save himself work. The same difficulty was experienced with the first compound engines, and is supposed to be one reason why the Elders, in their original engines, set the main valves to cut-off with full link at about one-half the stroke on the high pressure cylinder so that the engineer could only control the cut-off with the independent gear within that limit.

In the above experiments a horse-power was obtained in the compound engine of the U. S. Revenue Steamer Rush for 18.38 pounds of feed water per hour, the steam pressure being nearly 70 pounds. Now if the steam supplied to the engine in this case had been generated at about 160 pounds pressure, and used to operate another piston until its pressure was reduced to that actually used in the high pressure cylinder of the Rush, there would, on the basis that 80 per cent. of the total feed water was utilized in such first expansion, have been obtained about 40 pounds mean pressure, and 21.3 per cent. additional work, and the cost of the horse-power would have been reduced to 15.15 pounds of feed water per hour, which would have required for an evaporation of 8 pounds of water per pound of coal 1.89 pounds of coal per horse-power per hour. In average practice, it is believed the evaporation would frequently be nearer 7½ pounds than 8, which would increase the coal consumed to, in round numbers, 2 pounds of coal per indicated horse-power per hour.

This indirect method of procedure probably gives about the average performance to be expected under actual conditions in modern triple expansion engines of moderate size. A better performance is claimed and undoubtedly is obtained under experimental conditions and in the larger ocean steamers. It is thought that further gain must be looked for in the performance of the boiler, as it is not believed that very much better results than 15 pounds of water per indicated horse-power per hour may be expected.

A clear gain, however, of upward of 20 per cent. is very important, and by the same method of reasoning, it would appear that steam of still higher pressure might be expanded in still another cylinder and used again and again with economy. This corresponds with the conclusion from different premises stated in another paper presented with this, on the subject of "Cylinder Condensation, and the Reduction of the same by the use of the Compound Engine."

On the above basis, the limit of pressure would probably be fixed only by the capacity of the materials forming the steam cylinders and valve chests to resist the higher tensions and higher temperatures. It is probable that no material better than cast-iron will be found for steam engine cylinders, and this is made sufficiently dense to resist hydraulic pressure of several thousand pounds. Difficulty is, however, experienced in carrying pressures as high as 300 pounds with ordinary castings, and if the steam pressure were to be increased to or beyond that point more care would be necessary in selecting and manipulating the metal and moulds.

A steam pressure of upward of 300 pounds was successfully carried on a small steamer called the Anthracite, which was built in England on the so-called Perkins High-Pressure system, and visited this country in 1880 to demonstrate that high pressures could be safely and efficiently utilized to furnish motive power on an ocean voyage. Her machinery was tested by a board of naval officers in New York. With an average steam pressure of 316.5 pounds expanded 25.7 times in triple expansion engines, there was required 21.64 pounds of feed water per hour per indicated horse-power. The engines were small, the aggregate indicated horse-power developed being but 67.7. Still the cost was quite high, no lower, in fact, than has been obtained in exceptional cases with good condensing engines, and about what ought to have been expected with an ordinary compound engine using a steam pressure, no higher than 80 pounds. The same engine, tested in England by Mr. Bramwell, furnished a horse-power for 17.8 pounds feed water per hour, the water level being then carried lower, so that the steam was superheated considerably. The superheating of the steam at these high pressures is not desirable in practical work, on account of difficulty with the packings and lubricant. In the Bidwell experiments in Boston with superheated steam, it was considered that 450 degrees was the highest temperature which should be permitted. Proper precautions would indicate that even this temperature should not be allowed in sea-going engines involving so many responsibilities. The temperature of steam of 300 pounds pressure is about 420 degrees, which, in the opinion of the writer, is as high as can be carried satisfactorily in average practice either on sea or land. It seems certain that the highest steam pressure admissible would be limited by the temperature rather than by other conditions. In some of the marine engines using steam at 160 pounds pressure, it is found that there is a sufficient precipitation of water to permit the use of oil to be dispensed with after the engines are fairly started from port. The temperature due to this pressure is but about 370 degrees. In the Anthracite, designed for a higher pressure, with some superheating, all the packings were made of a metal adopted to obviate the necessity of using oil, and it is believed that if the steam be kept dry so as to secure economy, that a pressure even of 300 pounds will not be carried in practice without the use of some device of this character; and as any specialty always acts to limit general application, a less pressure will probably be generally adopted.

It is considered by the writer, that the proper limit of pressure has already been reached, if not exceeded, for the type of boiler used in large ocean steamers. Cylindrical boiler shells 12 feet and upward in diameter, and 1⅛ to 1¼ inches thick are not recommended, although used in practice. To limit the thickness even to the figures named it is necessary to use steel; and to procure even this of sufficient tensile strength, it is necessary, for such heavy plates, to use steel comparatively high in carbon, which is treacherous under ordinary manipulation. Not a plate of it should be used without annealing after every mechanical operation performed upon it. In fact, the whole boiler ought to be annealed after the plates have been riveted together, in order to overcome the injurious effects due to local strains produced in working it, but this is impracticable. Of course, boilers are made as heavy as this and but few fail, but the business cannot be considered on a safe and reliable basis so long as any fail.

As these are notes for discussion, it is considered well to state as an opinion that, since so many manufacturers have gone into the steel business, steel can no longer be considered in a commercial sense better than iron. The element of competition brings out steel which is altogether unfitted for boiler plates. Some boiler makers recommend their customers not to use steel, and it is only when it is carefully inspected to ascertain its quality before being made up, and also carefully inspected while the boiler is being constructed, that the steel boiler can be relied upon. It is so much more homogeneous and in every way desirable when the material is right that there is no danger of every one going back to iron; at the same time, the steel industry is bound to have its ups and downs on account of the improper material furnished by many of the manufacturers. The new ones are not entirely to blame, as some of the older ones send out inferior material under the spur of competition. It may be proper to say that no steel should be used for boilers, unless it be properly inspected or furnished by a firm which is known to keep up its reputation, and to send out nothing but what is suitable for the purpose.

The type of boiler used in most modern men-of-war is of the locomotive type, and has a smaller shell than the ordinary merchant marine boiler, and hence plates of proper thickness can be obtained without using steel so high in carbon. It would seem better to retain for these boilers the sizes now in vogue, rather than make larger ones requiring thicker plates, and also to retain substantially the thicknesses now in vogue, rather than to carry higher pressures requiring plates so much thicker as to necessitate the use of steel unusually high in carbon.

It is the opinion of the writer that boilers to carry the high pressures under consideration should be entirely without shells, except those of necessary separating drums with comparatively small diameters. On this system there will be no difficulty in carrying pressures as high as 400 or 500 pounds or more if the difficulties referred to in the way of lubrication, etc., for cylinders could be overcome to permit them. Sectional boilers are so well worked out for use on land, and there has been such measure of success even in sea-going vessels, that it seems safe to conclude that the use of higher steam pressures need not be limited by difficulties in the construction of the boiler.

There is no reason why pressures as high as those in use on the Western rivers, viz.: from 180 as high as 200 pounds, should not be adopted in general practice to secure economy of fuel, and the considerations above expressed in relation to the lubrication, etc., indicate that the pressure may be increased to, or nearly to, 300 pounds, when commercial and economical considerations demand such a pressure. It is probable that for pressures exceeding 200 pounds, quadruple expansion engines should be used. The experiments with the Anthracite appear to sustain such an opinion. The writer has not seen a record of actual experiments, giving quantitative results with triple expansion engines other than those of the Anthracite, though much information of a comparative nature is available which is subject to the objections first above indicated.*

The efforts of southern and western towns and cities to work up manufacturing interests through circulars showing natural and artificial advantages is having its effect on some of the more staid localities. For example, the Rutland, Vt., business men's association has published a circular setting forth the desirable features of that town, and not to be outdone in this direction the board of trade of Brattleboro, Vt., has something in the same line nearly ready for the press. Referring to this, the *Vermont Phoenix* says:

We hope our "Book of Brattleboro," when published, will tell the story of Brattleboro's attractions as pointedly and succinctly as does this Rutland circular. We like the spirit and enterprise of our Rutland neighbors, but on all essential points we can match the "marble city," and on several we can raise the bid.

Evidently there is commendable pride in both these Vermont towns; a determination not to sit quietly by and see the boom make islands of them, so to speak.

Engineering and Mechanical Notes.

BY F. F. HEMENWAY.

IV.

THERMAL VALUE OF COAL.

It has been experimentally determined that the amount of heat set free by the combustion of one pound of good anthracite coal is about 14,500 heat units. This is called the thermal value of the fuel. Only about ten per cent. of this heat is available for moving the piston of the best modern steam engine. Because there is such a loss of heat it is believed by many that the steam boiler is very wasteful. It might be supposed that only those who had no occasion to investigate believed that a large proportion of the heat lost in getting motive power through the agency of steam occurred in the boiler, but this does not appear to be true, judging from the fact that during the past five years several large companies,

*See articles by the writer on "Compound and Non-Compound Engines," *Transactions American Society Civil Engineers*, 1875; *Journal*, Franklin Institute, 1875-9; *Engineering* (London), 1875-6; see also D. K. Clark's Hand-Book; Cotterill, on the Steam Engine, etc.

*In response to a request, Mr. R. H. Buel, M.E., who keeps up his index rerum, calls attention to reports of the trial of the Anthracite, published in the *Journal* of the Franklin Institute, Feb., 1881, page 81; March, 1881, page 161; October, 1881, page 260. The data given in the text were taken directly from the Government report. Reference is also made to *Engineering*, February 29, 1884, page 185, where are published some indicator diagrams from triple expansion engines of the Isle of Dursey, and the daily coal consumption. These data would appear to indicate lower consumption than calculated in the text, but this is the case with all such data from ocean steamers, as the single set of indicator diagrams taken daily do not represent the average performance for the entire day. Reference is also given to data in regard to triple expansion engines in *Engineering*, February 27, 1885, page 224, and this refers back to page 173, same volume, where is given a complete list, with principal dimensions, of triple expansion engines constructed prior to January 7th, 1885.

organized to build novel forms of boilers, have issued circulars in which the claim was made of enormously reducing the expense of steam power by their improvements in generating steam.

As a matter of fact it is fairly settled that there are in use boilers in which it is possible to utilize as much as 80 per cent. of the thermal value of the fuel used, and even in the poorer forms of boilers about 50 per cent. is utilized. If we assume that in a good boiler 75 per cent. of the heat value of the coal is saved, it will be seen that the boiler is a fairly economical device. I refer to boilers used where there are no mechanieal objections to using such forms and dimensions as will give the best economical results.

HOW HEAT IS LOST IN GENERATING STEAM.

Air is by volume about 21 parts oxygen and 79 parts nitrogen. The nitrogen does not aid in combustion, except in diluting the gases, which, however, is a necessity. On the contrary it takes up heat from the furnace and carries it out of the chimney. It is necessary—owing to the imperfect manner in which it is supplied—to admit about double the quantity of oxygen to the furnace that can enter into the combustion of fuel, and this excess of oxygen carries away heat.

HEAT REQUIRED TO PRODUCE DRAUGHT.

In order to secure chimney draught the escaping gases must be of a high temperature as compared with the surrounding air. The loss from this source is generally a large percentage of the total loss.

UNCONSUMED CARBON.

Another source of loss is unconsumed carbon, which escapes with the chimney gases, and is known as smoke. The loss from this source has been enormously overestimated, and from these false estimates a great saving from so-called smoke-consuming devices has been claimed. I have never known one of these devices used without increasing the coal consumption.

As a matter of fact the loss of carbon in smoke is in the most aggravated cases very trifling. The late J. C. Hoadley made some experiments to determine this, and with bituminous coal, yielding dense black smoke, found the unconsumed carbon passing off with the gases to be about one-sixth of one per cent. of the fuel fired.

TOO MUCH AND TOO LITTLE AIR.

If more air than is necessary is admitted to the furnace the excess of air will simply take up heat and empty it out at the top of chimney. And here a mistake may easily occur. That is, knowing that if the temperature of a certain weight of gases can be lowered before passing to waste, less heat will be lost, they are frequently lowered by admitting an excess of air, especially behind the bridge wall, the result being loss instead of gain, notwithstanding a pyrometer would show a low temperature at the chimney.

But the loss from supplying an insufficient quantity of air is frequently more serious than that arising from supplying too much. This loss occurs in this way: When carbon is properly burned the result is carbonic acid, yielding the greatest possible quantity of heat. If the supply of air is insufficient the result is that part only of the carbon is properly burned, the remainder entering into the formation of carbonic oxide, a large percentage of the heat in this part of the carbon being lost.

LOSS FROM AIR LEAKS.

Boiler settings are likely to develop cracks, and there are frequently leaks around the iron work. Air gets through these cracks easier than through the fuel on the grate, which offers material obstruction to its passage. Serious loss may occur in this way, while if we judged of results by the temperature of the escaping gases quite the contrary would appear to be the case.

OTHER SOURCES OF LOSS.

There is very frequently a considerable percentage of water in coal; sometimes coal is even wet, on the supposition that there is economy in doing so. The water that goes into the furnace along with the coal is converted into a steam, at a direct loss of heat.

Some coal is lost by falling through the grates, and generally the better the quality of the coal, the greater the loss in this way.

Heat is also lost by radiation from the boiler and brickwork. It is only by the closest care and attention that all these losses can be kept at a minimum; it is easier to waste twenty-five per cent. of fuel than to save five per cent.

ITEM.		Main shaft.	1st Countershaft.	2d Countershaft.	3d Countershaft	Pulley of Machine.
Diameter of driving-pulley, in.		52	48	24	24	.....
Diameter of driven pulley, in.		.....	24	24	18	6
Width of belt, in.		12 (double)	12 (double)	8 (single)	4 (single)	.....
Thickness of belt, in.		¼	¼	1-8	1-8	.....
Distance between centers of pulleys, ft.		.....	20	9	9	11 1-6
Revolutions per Minute.	Calculated from relative diameters of pulleys, increased by thickness of belts.	138	297	589	771	3001
	Calculated from relative diameter of pulleys.	138	299	598	797	3188
	Actual by experiment	138	296	580	762	2776
	Loss, per cent. of calculated speed.	.....	0.34	1.53	1.17	7.50

The Slip of Belts.

BY RICHARD H. BUEL.

It seems probable, judging from the number and variety of speed indicators or revolution counters in the market, that observations of shaft velocities are frequently made by engineers and mill-wrights. But if this be so, very few of the observations have been published. The ordinary practice, apparently, in designing and erecting belt gearing to produce definite speeds, is to calculate the necessary sizes of pulleys, having given the speed of the main shaft and the diameter of the driving pulley thereon. In making this calculation, sometimes the true diameter of the pitch-line (or diameter of pulley increased by thickness of belt) is used, but generally the thickness of belt is neglected. Thus, if the main shaft carries a driving-pulley 48 inches in diameter, and makes 150 turns a minute, and it is desired to drive a countershaft at a speed of 300 revolutions a minute, the ordinary practice would be to give the driven pulley on the countershaft a diameter of 24 inches. But if the belt passing over these two pulleys had a thickness of ¼-inch, the speed ratio would be in reality

$$\frac{48.25}{24.25}=1.99$$

instead of 2, the desired ratio, and for a ratio of 2, the driven pulley should have a diameter of

$$\frac{48.25}{2}-0.25=23\tfrac{7}{8}''.$$

In cases where a single countershaft is used, the difference between the true and the approximate methods would ordinarily be slight. But if there are several countershafts, as is customary when very high velocities are to be attained, it is important to consider the thickness of belt in calculating the size of each pulley. It is still more important, in the latter case, to place the countershafts as far apart as possible, especially when the belts have great angularity in consequence of a rapid increase of speed ratios.

But even with the best possible arrangement of belt-gearing, and using belts of ample width, there is always within the experience of the writer a marked loss of speed (or difference between calculated and actual speeds) whenever several countershafts are interposed between driving-shaft and driven pulley of a machine, the loss being due, apparently, in part to the creep which occurs when the tight or driving portion of the belt becomes slack, and principally to the fact that the centrifugal force of belts at high velocities reduces their pressure on the pulleys. Several writers on the transmission of power by belts have laid down general rules for calculating the losses of speed in cases similar to those above mentioned. It is claimed by some persons that there is a definite slip, amounting to about 2 per cent. of the calculated velocity, so that the diameter of the driving-pulley should be increased or the diameter of the driven pulley diminished, in about the same ratio. Other writers state there is a loss of speed, varying from 2 to 4¼ per cent., according to the length of belt used.

These statements, if they have any practical value at all, which seems doubtful, are applicable only to cases where the belt velocities are moderate, because much greater losses of speed occur when shafts are driven at speeds of several thousand revolutions a minute. If sufficient data were obtainable for these latter cases, it might be possible to construct a reliable formula, but experimental data on this subject seem to be very rare. In the hope of drawing out some of the details gathered by practical observers, an example of the results obtained when several fast running countershafts were used, is appended. Figs. 1 and 2 show side and end elevations of the pulleys and belts of a machine driven from a main shaft, with three countershafts interposed. The diameters of pulleys, distances between centers of shafts, thickness of belts and observed speeds of shafts are given on the figures, and are repeated, with some additional data, in the accompanying table.

Fig. 1

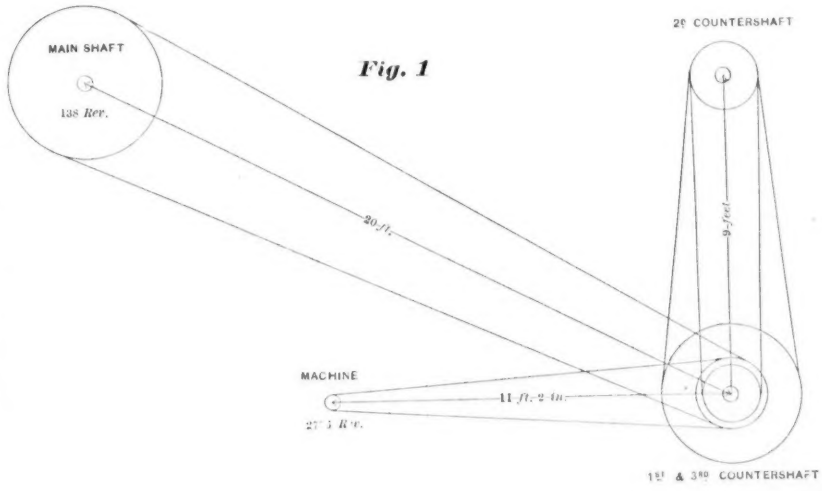
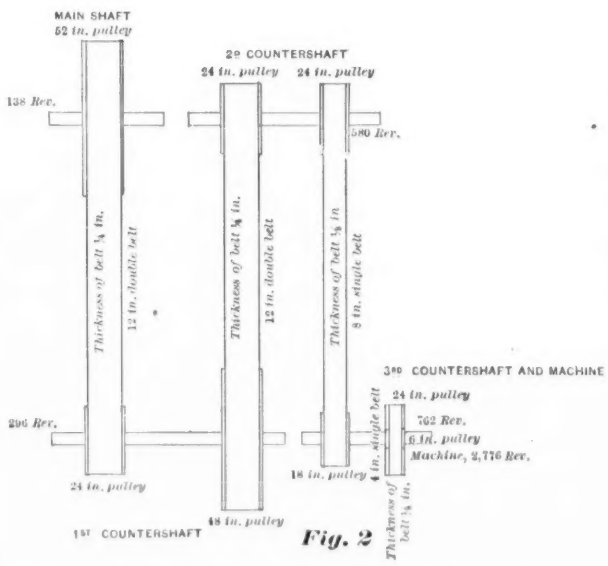


Fig. 2



The Stenographer Market Drooping.

"It would be a kindness to many poor girls and boys," said an old shorthand writer, "if the fact could be printed that the supply of stenographers is largely in excess of the demand. Encouraged by the comfortable salaries which some skilled stenographers earn, thousands—literally thousands—of boys and girls in Chicago have studied or are studying shorthand. Not many of them can hope to get situations. The fact should also be published that the so-called 'schools of stenography' in this and other cities, which advertise that they will secure good situations for all of their graduates, are delusions and snares. Their main purpose is to get the aspirant started, get his money, give him a smattering of shorthand, and then turn him out. No reputable business college or school agrees to secure positions for its pupils."—*Chicago Herald.*

The use of petroleum for steam making on ocean steamers appears to be making considerable progress in England. The latest advance is in using highly heated compressed air instead of steam. This prevents the waste of fresh water, which results when steam is used with the oil, and, it is believed, will go some distance in popularizing the use of petroleum fuel. The oil for fuel is now stored in the water ballast tanks, instead of in separate tanks constructed in the bunkers.

An amusing incident, showing how the search for natural gas is being conducted, and often successfully, in many places in various parts of the country, is narrated in the published account of a contract lately made by the citizens of an enterprising town in Missouri. They have just made an agreement with a firm of contractors to bore one thousand feet in the city limits for gas or water, the citizens seeming rather indifferent which. What if they should strike beer!

There is considerable evidence in the direction that there is to be something like a boom in railroad building in this country in 1887; previous experience will not warrant putting this down as an unmixed blessing.

English journals are keeping up a war of words against dishonest contractors who furnish miserably poor bayonets and swords to the Government. We admire their way of exposing frauds.

Suggestions in Machine Design.

A. J. SHAW.

NINTH PAPER.

Failure in friction clutches, when due to any fault on the part of the clutch, can usually be traced to one of three causes—insufficient area of friction surface, insufficient pressure between those surfaces, resulting in lack of driving power, and insufficient means of lubrication. These faults are supplemented in many cases by generally defective design and construction.

Some friction clutches seem to have been designed with the idea of having upon them the greatest possible number of projecting arms, levers and set screws; and with such success has the idea been carried out that they are more dangerous neighbors than a buzz-saw.

While it can hardly be expected that a friction clutch should be as symmetrical and as free from projections as a plain pulley, it certainly should be demanded that there be no projections, such as set screws, lever arms, etc., outside of or beyond the clutch, except such as may be absolutely necessary near the shaft.

While it is sufficiently true that friction is independent of the area of the surfaces in contact, and dependent on the condition of those surfaces and the pressure between them, it is none the less true that the area of the driving surfaces exerts a considerable and important influence on the driving power of the clutch. Conditions of durability demand that the pressure per square inch of rubbing surface shall not exceed a certain limit, so that while the resistance to slipping is the same for a given total pressure, whether the surface be small or large, its area, being the measure of the allowable total pressure, is also the measure of the capacity of the clutch.

Probably more friction clutches have been condemned for lack of durabilty than from any other one cause, and in many, if not in most instances, the lack of durability arises from a failure to make the area of the friction surfaces what they should be.

Friction clutches can be divided into two general types, in the first of which the friction is caused by pressure exerted parallel to the axis, while the second includes those in which it is generated by pressure normal to that axis. These, again, can be divided into two classes. In the first, to which belongs nearly all of those in common use, the transmission is by the friction of a single surface; in the second several friction surfaces are used, the power transmitted being proportional to the number of those surfaces. A friction clutch is not necessarily in the latter class because its friction surface is divided into two or more sections. It is in that class only when the method of subdivision is such that whatever pressure is exerted on one is transmitted equally to all the others, with a corresponding increase in the capacity of the clutch.

The Weston clutch is the only prominent representative of this class.

The common cone clutch, the simplest form of which is shown in Fig. 15, is the most generally known and used example of the first type.

With a given end pressure, the driving power of the cone clutch at the circumference of the friction surface is primarily dependent on the angle a, Fig. 15, which the side of the cone makes with the axis of the shaft.

In general terms, the less the angle a, the less the end pressure required to transmit a given power, other things remaining the same.

But if the angle be made less than 6° or 7° for metal on metal, the clutch will not disengage freely; and even with that angle means must be provided for positive withdrawal when disengagement is to be effected.

With an angle of 6° little if any end pressure is required to keep the clutches in engagement when once forced together.

If the angle be increased to 7½° or 8°, the end pressure will not be large, there will then be little liability to sticking, and the clutch will usually disengage of itself, if well lubricated. If the clutch be forced together by screw pressure it is good practice to make the angle of the cone from 15° to 15°, and some toolmakers have adopted an angle of 30°, but it is questionable whether, with so large an angle, the gain in power over a flat surface is a sufficient compensation for the increased cost of production.

Let W = the end pressure on the clutch.
a = the angle of the side of the cone with the axis.
f = the coefficient of friction.
P = the normal pressure on the friction surface, and
T = the tangential resistance to slipping at that surface.

Then, according to Weisbach,

$$P = \frac{W}{\sin a + f \cos a}$$

and

$$T = f P = \frac{f W}{\sin a + f \cos a}$$

These formulæ are often given

$$P = \frac{W}{\sin a} \text{ and } T = \frac{f W}{\cos a}$$

which are obviously incorrect, as they do not take into account the friction which resists the forcing of the cones together. This becomes evident if we make a extremely small, when, if

$$P = \frac{W}{\sin a}$$

were correct, the outward or bursting pressure would be very great, becoming infinite when the cone becomes a cylinder, or when $a = o$, which we know cannot be the case.

If we take $f = 10\frac{1}{2}$ per cent., which is a safe mean value for metal surfaces, with ordinary lubrication, we get the following values for P and T in terms of W.

a	P	T	a	P	T
6°	4.78	0 50	10°	3 61	0 38
7°	4.42	0.46	12°	3.22	0.34
8°	4.11	0 43	15°	2.77	0.29
9°	3.85	0.40	30°	1.69	0.18

While the driving power of a cone clutch is independent of its face, and, with a given end pressure, is dependent on the angle and diameter of the cone, it is essential to durability that the area of the frictional surface be such that the normal pressure shall not exceed, perhaps, 50 to 100 pounds per square inch for moderate and great velocities. Where the movement is very slow, as, for instance, in the "cone friction" in the apron of an engine lathe, the pressure can probably run considerably higher without disadvantage.

In fitting up cone clutches, which are not to be finished by grinding, the final cut should be taken with a flat tool, and care should be taken that the flat is set exactly in the line of movement of the feed, as it is necessary that the friction surface should be as nearly as possible smooth and straight.

It has sometimes happened that cone clutches which have had a driving capacity less than was expected have been found, on examination, to have such a surface as is shown in Fig. 16, which represents a section of a surface finished with a tool having a cutting edge slightly rounded. It will be noticed that while the nominal angle of the cone is not large, the actual angle of contact, indicated by the line b b, being that of the fronts of the steps into which the cone is divided, is much greater. As the driving power of the clutch, with a given end pressure, is dependent on this angle, its capacity is thus greatly diminished.

If the surfaces are finally fitted by scraping, it is better that the scraper marks lie at an angle with rather than in the line of the circumference.

Cone clutches which are faced with leather are better, for many purposes, than those driving by metallic contact. They are apt to work more smoothly, and are not as likely to cut or be destroyed by stray particles of grit or lack of oil.

On account of the large coefficient of friction, from 20 to 40 per cent. for leather on iron, the angle of the cone should be much larger than when both surfaces are of metal.

If we take 30 per cent as the mean value of the coefficient the angle should not be less than about 17°, if we wish the clutch to disengage of itself, and it should probably be not less than 20°.

Leather faced clutches of as low as 15° angle have been used when the pressure was obtained by a simple lever having a ratio of eight or ten to one, and have given excellent satisfaction.

When possible, clutches of all types should be so arranged that, when running, the pressures may be self-contained; that is, so that there may be no collar or end pressure caused by the necessity of keeping the driving surfaces in contact.

If it is not possible or convenient to avoid collar friction, it is better that the friction should be borne by the driving rather than by the driven part of the clutch, as in the latter case the transmitting capacity of the clutch is diminished by the amount of the frictional loss, while in the first instance the collar friction has no influence on that capacity.

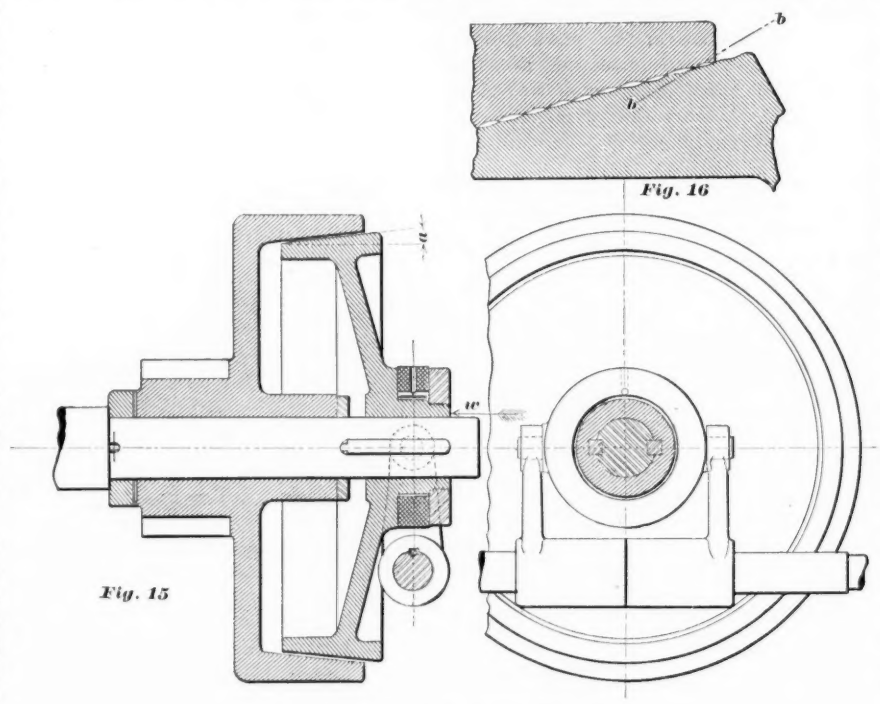


Fig. 15

Fig. 16

SUGGESTIONS IN MACHINE DESIGN.

At the rate at which cotton factories are springing up in the South close competition will soon be permanently assured.

The Education of Intuition in Machine Designing.

BY JOHN T. HAWKINS, TAUNTON, MASS.

A PAPER PRESENTED AT THE WASHINGTON MEETING OF MECHANICAL ENGINEERS.

It may, perhaps, at first thought, seem apochryphal to say that a boy's intuitive mechanical perceptions or tendencies may be educated; but a closer look at such a proposition will, I think, open up to our view an important channel through which the technical education of our boys may be modified to a considerable extent, and to their great advantage as practical men when they begin to assume the responsibilities of that part of their profession involving machine construction.

One of the greatest difficulties in ordinary machine construction (and particularly complicated machines containing a comparatively large number of parts, many of them of insignificant dimensions), is the proper designing of the various parts, so as to fit them best for the service which they have to perform, without resorting, to any considerable extent, to the mathematics for their solution. In a large proportion of such cases, the matters of strength and wearing and other qualities are important questions of consideration; and others, such as form, outline, and general appearance presented to the eye; accessibility for manipulation in the machine, their congruity with other members of the same machine; the most acceptable manner in which a given piece may be made to depart from what would otherwise be its most desirable form, in order to escape contact with some other member; the facility with which it may be put in its place in assembling the machine, or another substituted for it with least disturbance of the other parts, in case it should require to be replaced; the questions of cost of its construction, and in connection therewith the modifications of it permissible as conducing to cheapening of the methods of its production; what tools are available to be used for its production; and a thousand and one such questions as these depend largely for their solution upon what may be called the intuitive capacity of the engineer engaged in machine construction; and, in a large proportion of such, mathematical investigation can only be resorted to, if at all, in a most unprofitable way. The engineer is met at every turn with questions of this kind, which cannot profitably be subjected to the ordeal of figures, but which are no less important in a vast variety of mechanical constructions than those problems which more decidedly depend, for their successful solution, upon analytical processes.

There are also many questions of proportion which involve strength and wearing and other qualities which are so complicated in the kind of stresses to which the parts may be subjected, and the directions of application of those stresses are so involved with other considerations, such as some of those pointed out above, that analytical methods must fail, if applied to them, and in which the intuition of the engineer must almost entirely constitute the solvent. I take it that the faculty in man which may perhaps be properly defined as mechanical intuition is as much dependent upon education for its full development as a natural tendency to be musical, or an innate talent for painting, or any of the fine arts. It is well understood that, no matter how great a prodigy a boy may show himself to be in either of the directions last mentioned, the cultivation of his particular tendency is indispensable to any marked success in the application of it; and it is doubtless true that a natural mechanic may be developed by cultivation to as great an extent as a natural musician, or artist, or orator; and that, without development, either of them must necessarily be deficient.

Of course, it is admitted that the particular kind of training which will best develop this faculty in a boy is to be had in the practical application of his knowledge

and talents after leaving college; but I believe that a very considerable preparatory course in this direction may be followed in the schools, such that a young graduate of a technical school shall not—as is now very largely the case—upon entering upon the practical duties of a mechanical engineer in some manufacturing establishment—find himself to so great an extent unable to apply and make useful to himself and to his employer that which he has worked so hard to attain while at school.

One of the greatest difficulties attending the *debut* of a newly-fledged technical graduate in the practice of his profession as applied to machine designing is that he commences with a very decided tendency to carry out the exact methods which he has been pursuing at school; and the fact that employing manufacturers immediately find that these methods have to be so extensively reversed or subdued, if the young aspirant is to spend his time in a profitable manner, is a good indication that the education of what has been quite forcibly denominated the boy's "horse sense" by Mr. Dodge,* has been sacrificed during his college course, and that so much prominence has been given to what may be termed the metaphysics of engineering as to leave him very largely an impracticable. It is within my experience to find a young man who had graduated with high honors from one of our best colleges, upon first attempting to use the knowledge there acquired in machine design and construction, becoming completely lost in an effort to apply a comparatively high order of analysis to the designing of some part of a machine which could, in no profitable manner at least, be arrived at in any such way; and, not having had much previous training of that faculty which would enable him to design such parts properly and well, without resorting to a more or less elaborate application of mathematics, the result was anything but satisfactory.

In this way, we find that our young men are very much behind where they ought to be upon leaving school, in the particular direction of machine design and construction, and that they have, upon entering practical life, only begun another course of training as distinct from that which they have followed at college as can well be imagined. They are disappointed, armed and equipped as they feel themselves to be with what they suppose is all that is necessary to enable them to start out as designers and constructors of machines, to find that, in perhaps the very first task set for them, they are all at sea; and it is certain, in the writer's mind, that, if some system could be instituted in our technical schools looking to the greater education and development of mechanical intuition in a boy, schooling his eye to recognize good proportion and proper strength of material and the direction of application of the same, and stimulating and exercising his inventive faculty in such a way as to make him fertile in the resources which are so constantly demanded of the constructing engineer in machine designing, such an addition to the technical curriculum could be profitably made, even at the expense of some of the more analytical knowledge with which his mind is now more exclusively stored.

I am not of those who are inclined to belittle the importance of the higher mathematics in their proper place; but I do believe that the tendency in our schools is to impress the students with the idea, in too great a degree, that machine construction is dependent upon the application of mathematical analysis, and very much beyond what, in practice, there is any necessity for; and I believe that one of the most important things which could be instilled into their minds to-day would be the fact that, in designing any important machine (while in many ways the application of mathematical processes is indispensable to success) it is essential to know when and where not to attempt to apply these methods, and to be able to design, arrange, construct, and create in the proper places without them. Of course, it may be said, strictly, that there can be no piece of machine construction which cannot be subjected to, and its dimensions and other characteristics decided by, strictly analytical methods; but, in a very large proportion, such a course is economically out of the question, and they must be looked and thought out practically by the engineer's intuition—that is, his capacity to judge, unaided by abstruse computations, as to their best proportion and form, the material of which it is best to construct them, and many other considerations, such as indicated above, which are generally to be given their proper weight in the final designs.

One of the principal factors in this educational problem is economy. If it be accepted that, as above admitted, every conceivable problem of machine construction may be solved mathematically, in a vast majority of cases it would be the sheerest waste of time and money to attempt it; and, in this age of close competition and struggle for cheapening of every production, it is one of the very first considerations that a designer does not waste his time over analytical computations where his object may be attained in a more direct and simple manner; and perhaps there is no aspect of the question which applies itself more forcibly to the manufacturer or manager than that the tendency with our technical graduates upon entering upon the practice of their profession is to be too expensive, one of them rarely being able to compete in this respect with a young man who has had his mechanical aptitude or intuitions more thoroughly trained, though not in the possession of a tithe of the higher education with which the college student has been favored.

It may be contended that the manual training branches of such scools are intended and should be sufficient for the development of this mechanical faculty; but I think not—at least as they are now conducted; nor do I think it would be possible to combine the two in any desirable way. These are excellent for the training of the hand or the imparting to the student of "finger wisdom," as Mr. Partridge* has it; but very little in the way of deciding proportion, form, strength and adaptation of parts of a machine can be gotten in the workshop. It is in the mechanical laboratory and the drafting-room where the mechanical intuitions of the designer can best be educated and developed.

I do not know that I am prepared to formulate any system of training which shall better tend to the education and development of this mechanical intuition, in the technical schools There are, however, I imagine, many ways which will commend themselves to the instructors, in which something of this kind could be more extensively followed out; as, for instance, in all such schools there are more or less machines of various kinds in the laboratories, kept there for experimental or other purposes. From some machine of this kind, for example, there might be removed a single member; the machine turned over to the student, with the problem given, to make a sketch or drawing of this member, strictly by the intuitive promptings of his brain, and without any computation of its required dimensions or form. Then it might be compared with the removed member; or, if advisable, let him, after designing it, verify or disprove the correctness of his design by computations to any extent or depth necessary. Again, a member of a machine may have a specific form given to it principally for reasons entirely independent of its proportion and strength. In such a case, tender the problem of designing a substitute for it, as dissimilar in form as possible, to be equally well fitted to perform its functions, and without resorting to mathematical computation; or perhaps copies or blue-prints of working drawings could be gotten from machine manufacturers, and, in the same way, the student be given a piece to design which he has not seen, such as will be fitted to go with the rest, which he may see and consult. Let him see, in this way, how near he can come to what has already proved to be good in practice; and, if necessary, thereafter criticise both his own and the manufacturer's work by the most crucial methods of which he is capable. Some part of such a machine might be pointed out to which was given a specific form for reasons of accessibility or facility of exchange, and the student might be required to contrive some other means of achieving the particular end to be attained. Almost any part of a given machine may be produced in a great many ways, each resulting in a different cost of the piece produced. In such a case let the student devise and indicate the proper methods to be pursued to produce it at the least cost, modifying his design to conform to this consideration. Very many such problems as these might be instituted by the instructors, which would constitute a very excellent training of the mechanical instinct in the student, and his inventive faculty be exercised and developed.

One difficulty which might be mentioned in the application of this intuitive or instinctive method so largely indispensable in machine designing, is that working drawings made upon some small scale are, to the eye and judgment of most men, very misleading. A given detail of a machine drawn, for instance, one-quarter size, will appear very differently when laid out full size; and, in my opinion, there is no one feature which requires more thorough training, where a designer is to rely upon his unaided judgment, than this; and I believe that one of the best possible exercises for the student, looking to the fitting of him for a machine designer, would be to make drawings first to some fractional scale, and to draw them out afterward roughly on the black-board, or on large manila sheets, full size, designing the part or parts, to all intents and purposes, first upon a small scale, then drawing them full size, to enable him to verify by his eye and judgment the correctness of the smaller drawing.

I am aware that to all this some will cry, "Rule of thumb!" But I believe, while I deprecate any such exclusive reliance upon it as is too often permitted and practiced, this same rule of thumb may be made a most excellent one, if properly hedged in and its good points only developed and applied in machine construction. I believe that, in our technical schools, the rule of thumb is too persistently sat upon, and that it is capable of being brought to a sufficiently high standard, by proper systematic development, to be of incalculable value to the mechanical engineer.

The writer advances these thoughts more with a view of eliciting discussion than of attempting to point out how the object sought could be best attained—in the profound belief, however, that much which may be known under the terms mechanical aptitude, intuition, instinct, or inventive faculty, is now neglected in our schools, while it is what should be educated, nourished and developed to the greatest degree, in order to turn out successful mechanical engineers.

* Trans. A. S. M. E., vol. VI., p. 543.

* Trans. A. S. M. E., vol. VI., p. 535.

That Boiler Explosion.

In our issue of May 28th we published a letter from Mr. W. Barnet LeVan, in which he makes objections to some of our statements in regard to a rotary boiler explosion which occurred in Paterson, N. J., on April 23, 1887. In this letter the following paragraph appears:

Third.—Last fall there were three small rag boilers, and it being deemed more economical to have one large one in place of two of these, one was ordered of the Cooke Locomotive Works, but it was not completed according to the specifications. This new boiler was not to take the place of the one just exploded—as they expected to still use that for certain work.

Since the above appeared, Mr. John S. Cooke, President of the Cooke Locomotive and Machine Company, has requested us to state that the boiler in question was built exactly according to the directions given by the Ivanhoe Paper Company, and anything stated to the contrary is not true. Mr. Cooke also states that after the work on the boiler had advanced a change in the original design was requested by the Ivanhoe Paper Company, which would increase the cost of the boilers, and which the proprietors of the mill were not willing to pay. During the negotiations in regard to the extra cost, work was suspended and so much time lost that the boilers could not be finished by the time wanted. When that time arrived the order was countermanded, and efforts were made by the Ivanhoe Paper Company to effect a compromise, but without success.

LETTERS FROM PRACTICAL MEN.

Locomotive Gauges.

Editor American Machinist:

The first steam gauge with a hand, or pointer, and dial—called a steam clock—had a round case and a pipe connection on the side of it, or rather on the bottom of it, and so all the gauges built from then till now are like it externally. They have been changed, improved, nickel plated, embossed, picturefied, etc. Some have diaphragms that lay down flat and some that stand up on edge; some have bent tubes, steam connected at one end, and some in the middle, but every one I ever saw had that confounded pipe connection in the bottom.

There is the brass nipple, then the brass nut, with the monkey wrench trade marks on its six or eight sides, then the crooked pipe. Does this pipe get hot? Try to scour or clean this gauge and pipe and let each blister on your hands count for one degree and you will see. This connection is unsightly, always marred and black, and being close to boiler is hard to keep clean. You cannot clean easily or well around it, and it is often in the way.

I run a consolidation engine where this pipe and nut are so close behind the throttle gland that it cannot be half screwed up. Why cannot this pipe connection be behind the gauge? It could go through the boiler bracket and need not be polished. It could be heavier and stronger, the wrench-deformed nut would be out of sight, and the fireboy could get the dope and polish on a smooth, round surface.

Air and vacuum gauges should be so made; it will cost no more than the present style, and the crews would count it a handy idea. I hardly expect to see all the old gauges thrown away nor even rebuilt to my idea, but my advice is like salvation—it is free.

JOHN A. HILL.

Denver, Col.

The Effects of Hardening Steel.

Editor American Machinist:

Under the above heading Mr. Richards probably states exactly the experience that a majority of steel users have had.

Steel usually expands in cross section and contracts longitudinally in hardening. Let those who base their opinion that steel shrinks in hardening upon the fact that holes are smaller after than before, remember that there is quite a difference whether a large or small volume of steel surrounds the hole. For instance, in a piece 3″ diameter with 1″ hole the hole will shrink; make the hole 2½″ diameter and it will expand.

Difference in heat at which steel is hardened will make a great difference in this change in volume. Difference in condition as affected by working or annealing makes a great difference. Different tempers of steel act differently, not because of different makes, but because of different temper.

There is probably no doubt but the average result of hardening, as ordinarily done, is to increase the volume. This is no doubt due in part to purely mechanical, not chemical causes, particularly in large pieces. When heated the steel is expanded. In cooling the outside becomes fixed and rigid, while the inner portions are still expanded and hold the outer portion from going back as nearly to normal size as

would take place only for the resistance offered by the expanded internal parts. Who ever saw any square blocks of any considerable size drop into the same niche after hardening which they fitted before?

This matter of so-called shrinkage by hardening is a very important one, which can to a considerable extent be controlled. In the use of many dies where .0005″ wear would call for a new die only for the fact that re-hardening will shrink the hole, it comes to be believed that certain makes of steel, as Mr. Richards says, will shrink, while others will not. Carbon, condition, treatment, etc., etc., all come into the account.

S. W. Goodyear.

Steam Pipes Causing Fire by Friction.

Editor American Machinist:

S. E., Newton, Mass., answers his question why the wooden lagging on locomotive boilers will not fire, viz.: "Tight metal jacket outside the wood." The wood will go into tinder, which might fire very easily, if there was no "tight metal jacket." A wooden door, with a tight metal jacket, is the best kind of a fire door for mills and factories.

I saw an instance in which a steam pipe did start a fire. The pipe was against and fastened to a white pine board, and led live steam to a pump on the second floor of a brewery. Near the pump was a grain-crushing machine, running almost constantly, which caused considerable vibration to the floor. I noticed smoke curling up at one of the fastenings, and thought it was water dropping on the pipe and steaming off; but almost at the same instant there seemed, from the rapid movement of the smoke, a draft from somewhere, the smoke diminished, and a bright flame showed itself on the board and apparently half way round the pipe. An examination showed that the board was charred about half through, and that the motion of the pipe had filed off the tinder which had collected on each fastening, and everything was ready to start a fire in the way which we have all heard about; that is, by friction, as rubbing the pointed end of a stick into the body of another. The pipe showed that there had been considerable up and down movement, as it was worn bright and smooth under each fastening.

During a very cold spell a few years ago, there was a fire in Toledo, Ohio, which destroyed a valuable block of buildings. I claimed that it was caused by the steam-heating pipes, which ran along boards, through floors and wooden ceilings, and even through holes bored through joist; but the idea was scouted. As there had been a dance going on for several hours previous, I still think the steam pipes caused the fire.

J. A. Browne.

Annealing Steel.

Editor American Machinist:

We wish to call your attention to a method of annealing steel as practiced by us, by which we can anneal the hardest steel perfectly, and that without the use of anything but a small forge.

Take the piece of steel that you wish to anneal and heat to a dull red heat in a forge or other suitable furnace, after doing which you must desist from blowing. Simply allow the piece to remain in the fire until it goes out of itself, and you will find that the fire does not go out in a few minutes as it would otherwise do, but the heat of the steel keeps it burning sometimes three or four hours, during which time the heat gradually decreases until cold. The same may be applied to wrought and cast-iron used in dynamo machines for rendering them perfectly soft.

We do not give this as anything new, as for all we know it may have been practiced by a great many others in our business; but should it not be generally known it may be of some service to some of the many readers of your valuable paper.

J. Buchel & Bro.

New Orleans, La.

Machine Design.

Editor American Machinist:

Referring to the latter part of Mr. A. J. Shaw's eighth paper on machine design, which appeared on page 4 of your issue of May 21, I wish to say that Mr. Shaw, in the case of the long pinion stud as shown in Figs. 12, 13, and 14, is altogether wrong.

While it might not be needful to warn the experienced designer against such methods as Mr. Shaw pronounces "better," young persons might be misled by the positive assertion in regard to this detail.

Fig. 12 shows an ordinary form of stud, and the form which is in all cases the best form of stud to use. It consists of two pieces only, the stud and its nut.

The reduction in diameter at the neck does not weaken the stud or make it less stiff. The strain on the neck, between the body of the stud and the nut, is tensile only; not shearing or bending, and may be reduced below the proportion shown in the engraving without detriment.

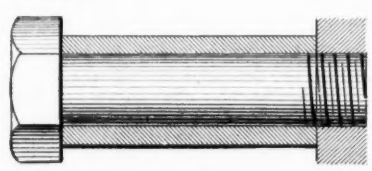
Fig. 13 shows a modification with five pieces instead of the two in Fig. 12, and involves (besides the three extra pieces, and the labor of making, and drawing, and listing, and handling in assembling) the destruction of the center in one end of the stud.

A really good designer is very careful to preserve the centers of all turned work.

The only advantage in stability, gained by Fig. 13 over Fig. 12, is due to the increased base diameter given by the collar resting on the apron of the carriage.

The modification shown in Fig. 14, where the threaded end of the stud is screwed into the plate, is abominable, and should never be employed under any circumstances for any stud whatever.

Where a nut cannot be used the next best construction is a screw and thimble, as shown below.



Screw and Thimble.

This makes a good job. The thimble or sleeve can be of cast-iron, as it sustains a compression strain.

I can fancy the forcible language which a builder of lathes would use in requesting Mr. Shaw to change a drawing of a lathe apron with the "improved" five piece stud back to the old two piece style, but I cannot quite conceive how Mr. Shaw came to make such very curious errors in the matter.

Easy Way.

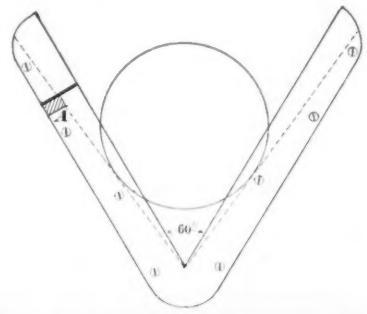
Standard Trade Catalogues.

Editor American Machinist:

Years ago I thought Chordal rather notional about his catalogues. Now I think he adopted the cheapest and best method of arrangement for that time, but a new departure has been made since then. They "build" their catalogues on the plan of the old fashioned singing book. While this style is perhaps pretty in a way, the inconvenience of a book in that form is advanced about forty per cent.

My "kick" is about the lack of a standard catalogue. Calling at an office of a manufacturing concern a few weeks ago, looking after machinery, I took away with me their catalogues, five in number, for examination. The first was $3\frac{1}{2}'' \times 5''$, 100 pages, singing book style; the second, $4'' \times 8\frac{1}{2}''$, 46 pages, singing book pattern; the third, $7'' \times 10''$, 40 pages of the same order; the other two were of the regular book shape, $5\frac{1}{2}'' \times 6\frac{3}{4}''$, 24 pages and $11'' \times 8\frac{1}{2}''$, 30 pages respectively. I examine a great many catalogues in a year, and lots of them go to the waste basket that would otherwise be preserved were it not for the fact that they are unhandy for the very purpose for which they were designed, *i. e.*, books of reference. Chordal's method won't fit any more without almost infinite variation. I have made my protest and would like some help. Manufacturers are adopting standards in every line, and I think a standard size for catalogues would be the easiest standard imaginable for adoption.

Holland, Mich. F. L. Johnson.



Tool for Laying Out Hexagon Nuts.

Editor American Machinist:

The sketch illustrates a tool for laying out hexagon nuts, and is very handy to patternmakers; section is shown at *A*. The upper part can be a light steel blade and lower part of hard wood. After turning pattern to long diameter of nut, place the tool on pattern like a center square, move it around and mark off sides—keeping the two under edges in contact with circle—this is better and quicker than dividing off with compasses and then marking sides.

I do not claim any originality in this, but having shown it to several who say they never saw such a tool, I thought some of your readers may find it useful, as I have.

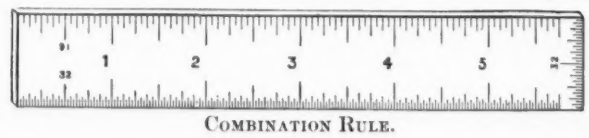
P. S. Dingey.

Graphite in Steam Cylinders.

A correspondent inquired, in our issue of April 23, how to use graphite in the cylinders of steam engines. We have heard of its being mixed with water and fed to the cylinder through a tallow cup provided with a stop cock. How well it works when used in this way we have no means of knowing. Recently we saw it in use on an 18″x36″ engine, running under 90 lbs. steam pressure, and heavily loaded. The regular oil cup was in use on the cylinder, feeding cylinder oil or valvoline. In addition to this there was a small pump, by means of which a thick mixture of graphite and oil was forced into the steam chest, at intervals of about two hours. The engineer in charge spoke very highly of the use of graphite as relieving the strain on the valve stem, and from observation we feel sure that he was right. It is said to keep all the wearing surfaces in the cylinder and steam chest highly polished and smooth.

Wyke's End Measure Combination Rule.

This rule is a steel standard, graduated entirely across the end as well as on the edges. It is intended for use in places where other scales cannot be used owing to limited space, being a long rule, a short rule and a gauge for certain purposes in one tool. They are made in different lengths by J. Wyke & Co., East Boston, Mass.



Combination Rule.

If it is true, as reported, that railroads discriminate against shippers who ship by canal in summer, they should be restrained without needless delay. The State of New York, as well as New York City, owe much of their prosperity and present advancement to the much abused canal system, and to the Hudson river, and future prosperity is largely dependent on keeping these means of transportation untrammeled.

Work has been resumed on the Hudson river tunnel after a rest of five years. This time it is expected that the job will be pushed to completion.

Modern Locomotive Construction.

By J. G. A. Meyer.

FORTIETH PAPER.

PISTONS.

Locomotive pistons consist of two distinct parts, namely, the piston head, and the packing. Locomotive pistons may also be divided into three classes, according to the construction of the head; the first-class embracing all the pistons in which the piston head is made up of more than one piece, such as shown in Figs. 206 and 207; this class of pistons we may call the "built up piston." The second class will embrace the pistons in which the head is cast hollow, such as shown in Fig. 208; this class of piston we may call the hollow piston. To the third class will belong the solid piston, such as shown in Fig. 209.

The Built Up Piston.—Figs. 206 and 207. In this figure the piston head is made up of the following pieces: The spider, which is marked *A*; the follower plate, or simply the follower, marked *B*; and the follower bolts *C*, which unite the follower to the spider.

In American locomotives the spider *A* is made of cast iron. It should be made, in fact the whole piston should be made, as light as possible, and consequently its metal must be judiciously distributed, so as to obtain, with the least amount of metal, the maximum strength. By so doing, not only steam will be saved in avoiding moving an unnecessary weight of metal backward and forward, but less counterbalance will be necessary, besides gaining other advantages. The spider is generally keyed to the piston rod by the key *I*; sometimes the piston is secured to the rod by means of a nut, as shown in Fig. 208. In very large pistons, such as are used in stationary or marine engines, the depth of the spider (corresponding to the depth *X* in Fig. 206) is obtained by calculation; the width of the packing (corresponding to the width *y* in Fig. 206) that is, the distance from the face of the flange of the spider to the face of the follower is generally made equal to $\frac{1}{6}$ to $\frac{1}{8}$ of the diameter of the piston; the former proportion being adopted for pistons of comparatively small diameter (as large as a locomotive piston 22 inches in diameter) and the latter proportion for pistons of very large diameter. Consequently, in stationary engines and also in marine engines we often find pistons whose depth at the center is greater than that at the circumference, so that when one face of these pistons is flat the other face will be part of a spherical surface. In locomotive pistons the depth *X* of the spider is determined by the key which holds the spider to the piston rod. The dimensions of these keys, depth of spider and size of piston rods will be given in another paper. Now, practically in locomotive pistons of small diameter the necessary depth *x* of spider does not give us an excessive depth for the packing, and in locomotive pistons of large diameter the depth *x* will give a depth of packing, agreeing with the proportions given for stationary and marine engines. Therefore the faces *s* and s_2 of locomotive pistons are generally flat, sometimes slightly tapered towards the circumference, as shown in the figures.

The follower plates (Figs. 206 and 207) are made of cast-iron, and usually cover the whole open end of the spider when follower bolts are used, as shown in the figure.

Follower Bolts.—In any mechanism having such a high rate of reciprocatory motion as a locomotive piston, bolts, unless carefully fitted, are liable to become loose and work out. To prevent the follower bolts from becoming loose they are extended into the spider through a distance which is at least equal to three times the diameter of the bolt, and great care is taken to make a good fit of the thread. Sometimes, on account of the rust, trouble is experienced when the follower bolts are to be taken out of the spider. To obviate this difficulty a few

locomotive builders insert brass plugs into the spider, see Fig. 210; these plugs are tightly screwed into the spider and then riveted over at the ends. In these brass plugs holes are drilled and tapped to receive the follower bolts, and thus preventing any rust from causing a difficulty in removing the follower bolts when it becomes necessary to do so.

Piston Packing.—A great amount of thought, labor, and expense, has been expended in constructing and perfecting a piston packing which shall give satisfaction under all circumstances, and, consequently, many different kinds of piston packing are in use. But we have noticed that the kind of piston packing which has given the best satisfaction, so far, is one in which two distinguishing features are found, namely, durability and simplicity; and indeed these two features we should expect to find in any good piston packing, because any packing that will not remain steam tight for a considerable length of time is troublesome, annoying and unprofitable; and a packing which does not possess the feature of simplicity is dangerous, particularly so in fast running engines, such as locomotives.

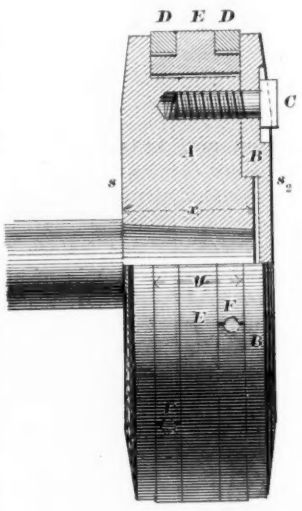


Fig.206

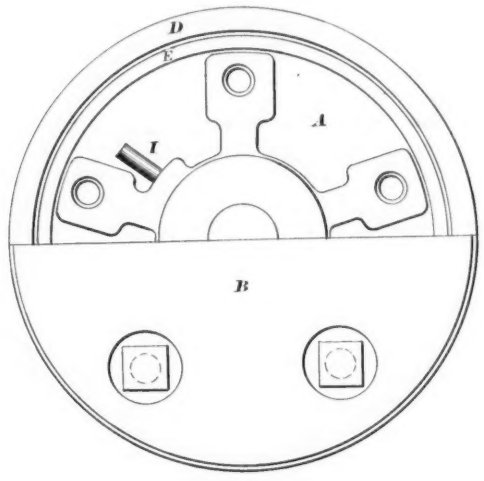


Fig.207

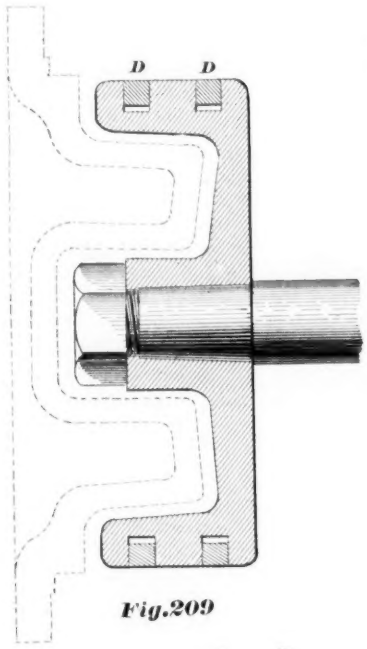


Fig.209

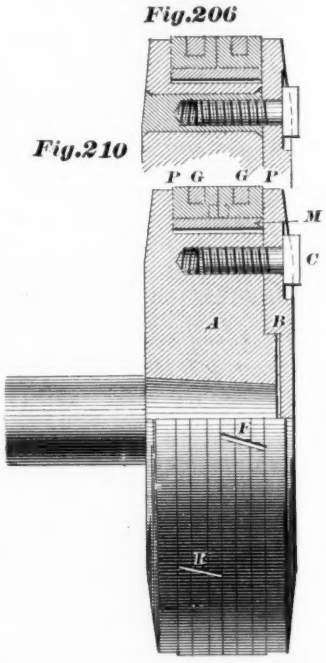


Fig.210

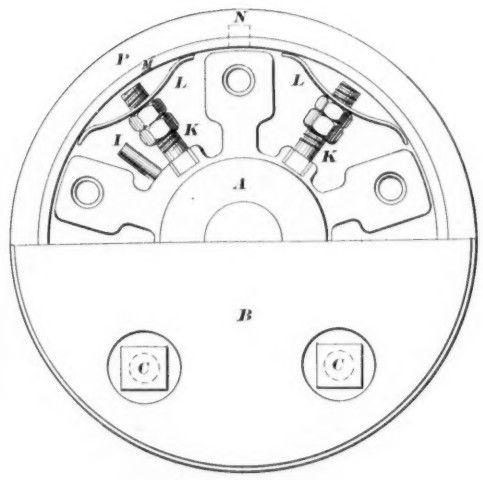


Fig.212

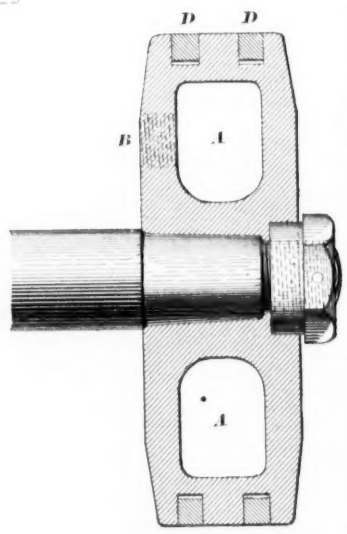


Fig.208

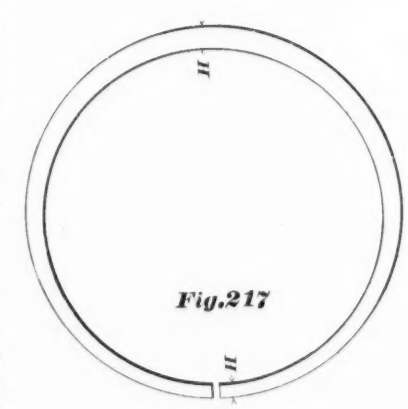


Fig.217

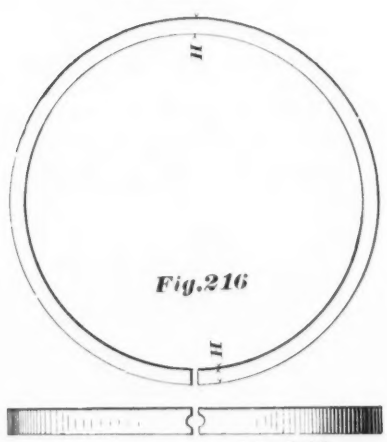


Fig.216

Fig.218

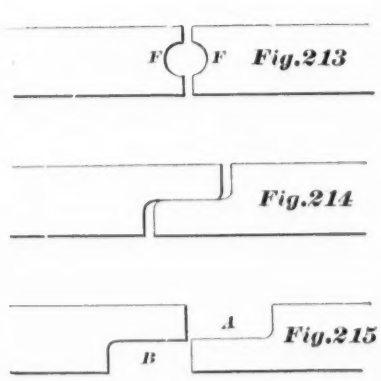


Fig.213

Fig.214

Fig.215

In Figs. 206 and 207 we have represented a piston packing which, on account of its simplicity and durability, has in late years gained great favor among engineers, and is certainly an excellent piston packing for locomotives. This piston packing simply consists of two cast-iron rings *D D*, and one cast-iron *T* ring marked *E*. We call this ring a "*T* ring" because its cross section resembles a *T*. The rings *D D* are cut open in one place, and, consequently, are called single cut rings. Two ways of cutting these rings are generally adopted. Some master mechanics will have the rings *D D* cut as shown in Fig. 213. Here a hole *F F* is first drilled and made oblong in the direction of *F F*, then through the center of the hole the ring is cut open square across. Care should be taken to cut out sufficient amount of metal, so that when the packing ring is placed in the cylinder the two ends of the packing ring will not touch each other, but will leave an opening sufficiently great to allow for the expansion of the ring when it becomes hot. The same remark applies to the hole *F F*; this should be made long enough, as shown, to allow a sufficient clearance around the pin which is inserted in this hole and driven into the *T* ring, otherwise the expansion will force the ends of the packing ring against the pin and prevent the ring from acting as it should do. The object of this pin is to prevent the ring *D* from moving around the *T* ring. When the rings *D D* are cut in the manner just described, they are turned about $\frac{5}{16}$ to $\frac{9}{16}$ of an inch larger in diameter than the bore of the cylinder, so as to give the rings an inherent elasticity. The other way of cutting these rings is shown in Fig. 214. Here half the width of the ring is cut out through a distance of about $\frac{7}{8}$ of an inch, which enables the ends of the ring to overlap each other about $\frac{3}{4}$ of an inch. The writer believes that when a ring is to be cut in this manner the best way to pursue will be as follows: First turn the ring large enough in diameter to allow for the metal to be cut out. Then cut the openings *A* and *B*, Fig. 215, through half the width of the ring, and each about $\frac{7}{8}$ of an inch long. When these are cut press the ends together, so that the ends will overlap each other about $\frac{3}{4}$ of an inch; through these reduced ends drive a small temporary pin, and then again turn the ring to fit the bore of the cylinder, after that take out this pin, as it has served its purpose. Other pins are driven in the *T* ring, which fit loosely into holes drilled in the packing rings, to prevent the latter from turning around the *T* ring.

As to the proportions of the cross section of the rings *D D* (see Fig. 206) a difference of opinion exists. Some master mechanics make the width of the ring greater than the depth, others will insist on having the width smaller than the depth, but more frequently we find the cross section to be a square. The writer believes that packing rings whose cross section is $\frac{1}{2}$ of an inch square will give good satisfaction for cylinders 9 inches in diameter; and this cross section should be gradually increased for cylinders of larger diameter, in a manner which will bring the cross section of the ring to $\frac{3}{4}$ of an inch square for locomotive cylinders 22 inches in diameter. In the majority of locomotives the depth *H* of rings *D D* remains the same throughout as shown in Fig. 216. They are made to press against the interior surface of the cylinder by their inherent elasticity, and when this elasticity is exhausted through constant wear, it can be partially restored by a few judicious light blows of the hammer in the inside of the ring. Since these rings will wear the most at the opening, and in time wear the cylinders oval, instead of cylindrical, it has been assumed that these rings have not a uniform pressure all around against the cylinder surface, and this is true. Hence, on account of this unequal pressure, some master mechanics make these packing rings of the form as shown in Fig. 217, in which the depth *H* at the opening of the ring is less than the thickness *H* opposite the opening. The object aimed at is, of course, to obtain as near as possible an equal pressure of the ring against the interior surface of the cylinder. But from the writer's experience, and upon careful inquiry, he is led to believe that rings of uniform depth throughout, as shown in Fig. 216, will give as good satisfaction as that shown in Fig. 217.

Since cast-iron is generally considered to be as good a metal as can be used for piston packing rings, as it wears well, particularly when the metal in the cylinder is hard, as it should be, rings of the kind just described need but very little inspection, and can be used for a considerable length of time.

Sometimes the packing rings are cut into four or more pieces, and made to press against the interior cylinder surface by the aid of springs; the advantage claimed for this arrangement is an equal pressure against the cylinder surface. But cutting the rings into so many pieces, and then introducing springs, interferes with the simplicity of construction, and therefore packing of this kind is not very often used.

T Ring, Fig. 206.—The outer surface of the *T* ring is turned to fit easily the bore of the cylinder, so that when the *T* ring becomes hot, its expansion will not interfere with its free motion in the cylinder. The width of the *T* ring must be turned to such dimensions that it can be held firmly in position by the follower plate, when the latter is screwed to the spider. The recesses turned at each corner of the *T* ring will form the grooves for the packing rings, when the piston is put together. Of course, the *T* ring is not cut open. The advantage obtained by the use of a *T* ring is that the packing rings can be readily placed in or taken out of the piston, without forcing the ends of the packing rings apart to place them into the grooves, as must be done when the solid piston is used. The packing rings must fit in the grooves very accurately, not too loose, yet free enough to allow the rings to adjust themselves to the interior surface of the cylinder. When both the packing rings are placed in position, their openings or cuts should not be in a straight line, but should be staggered, having a distance of five or six inches between the openings *F F*, as shown in Fig. 206. It is always best to allow the openings of the rings to lie in the lower part of the cylinder; but in no case should the opening of the rings be placed over a steam way opening. The reason for this is that, since the ring is turned a little larger in diameter than the bore of the cylinder, the packing rings must be compressed in placing them in the cylinder; and, now, should the hold or grip upon them be lost through some accident or mishap, while in the act of placing the rings in the cylinder, the ends of the rings may fly into the steam way, and generally in such cases the ring must be ruined by cutting it into several pieces, in order to take it out of the steam way.

One-half ounce of camphor dissolved in one pound of melted lard, the scum removed, and a little graphite mixed with it, is said to be excellent to keep tools from rusting.

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NEW YORK, JUNE 11, 1887.

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The Value of a Draftsman.

In these times of competition, energetic machine shop proprietors will naturally and continually look around their shops to find room for improvements in tools employed, or in the system of doing work, which will enable them to reduce the cost of their production or specialties to the minimum; and when a proprietor finds that others can do the same work for less money, then the question—where can we economize?—presents itself more forcibly than ever. Hence reorganization of the workshop system, new, and a different class of tools, and various other ways which will reduce the expenses suggest themselves, and are often acted upon, only to find in the end, that the result of all the changes made, labor and expenses incurred, has not reduced the cost to the desirable extent; in fact, disappointment is the only reward for all the pains taken. In such shops there may be found, and frequently is found, a small corner, often in an out-of-the way place, which no one thinks worthy of any particular notice or attention, since this corner is believed to be only a place in which to stow away what is considered a necessary evil, namely the much-abused draftsman. That the drawing room is sometimes a hindrance instead of a help is true, but that is the fault of the proprietor who engages incompetent draftsmen, or young men knowing nothing of the business, but into whom the proprietor expects to infuse some of his brains, and in a few months make these young men as smart as himself.

This operation we have not yet seen or heard of as successfully accomplished, but we have known it to be a miserable failure. We are of the opinion that a drawing office staff, composed of talented men and guided by an able and experienced chief draftsman who thoroughly knows his business, or guided by an intelligent managership, is indispensable in a machine shop employing a hundred men or more; particularly so in the larger establishments. When the necessity to economize becomes apparent, we would suggest to begin in the drawing room, as here true economy will originate; not by reducing the staff, as this will often cripple the usefulness of the drawing office, but rather increase it by competent men, so that this department will become a leading one, and not one that follows, making the drawings after the machine is finished. A good chief draftsman and his assistants will take pride in being the leaders and furnishing accurate, simple and plain drawings in every department of an establishment in plenty of time for the execution of every order, keeping all the machines humming, and enabling all the workmen to proceed without delay and without confusion; thus bringing the building of a machine or a number of various machines often of a difficult design, and all of which must be erected on the floor at one time, to a successful and profitable conclusion. But to do this requires an immense amount of labor in the drawing room, hence we say that true economy consists in having an ample staff of well paid men in the drawing room. There are establishments which do not reap the full benefit of the capital invested, just because the management entertains the foolish notion that suitable draftsmen can be picked up at any time and for any compensation it may seem fit to offer. These latter remarks are particularly applicable to the chief draftsman. In late years the responsibility of the chief draftsman has been increased, as in large establishments he is now responsible for the design and the successful operation of a machine, which was not the case ten or fifteen years ago, as then the superintendent was held responsible for the design, and the chief draftsman for the accuracy of his drawings. But now the chief draftsman often occupies the position of mechanical engineer under the title of chief draftsman, and therefore his value in an establishment is sometimes underrated, or not appreciated as much as it should be. It is still less appreciated if he is an able man, who from one year's end to another carries to a successful conclusion, without any fuss, mistakes or difficulty, the designs of machinery entrusted to his care. His very modesty may appear to indicate that the profession of draftsman does not amount to much.

As soon as an establishment recognizes the fact that draftsmen capable of holding responsible position are, and must be, experienced men, and that experienced men must be selected from those who have been actively engaged for years in the business, and, therefore, cannot be found among young men just entering a professional career, just so soon it will recognize the value of a good chief and able assistants; and without these, economy, cheap production of first-class machinery at a fair margin of profit and successful competition with other firms is impossible.

A Dangerous Monopoly.

Although this is the era of State protected monopolies, it seems that some of them are not satisfied with the valuable privileges thus afforded them to crush out opposition. The recent trial of agents of a branch of the Standard Oil Company, and their conviction of conspiracy to blow up or otherwise destroy a rival oil refinery is a recent case of more than usual public interest. The method adopted was to bribe a trusted employe of the rival works. Here is a danger which threatens the whole community. If the Standard Oil Company, with its immense wealth, wrung from the people by aid of legislative enactments, resorts to bribery, pure and simple, not only to influence law making, but to destroy property that stands in its way and otherwise break laws that would restrain it, what can the people do for protection? Its resources are practically unlimited, and its internal organization is close and cunning. In a few years more at its present progress, coupled with the rapid progress of other monopolies, alike fostered by legislatures, how much liberty will be left to the people? The Standard is too strong to be checked by any combination independent oil companies could make at this time, nor is there any possibility of forming a combination of different business interests to check it. Monopoly loves and sympathizes with monopoly, and if the Standard were not strong enough alone it could form a giant combination with other big powers of similar cast. How then is the dangerously exercised power of the cormorant aggregation of wealth to be met and thwarted? We feel assured it can be done only by repealing the unjust laws by which it enjoys extra privileges and by enacting and rigidly enforcing laws to stop its aggressions upon the rights of the people. If the people continue to elect legislatures subservient to the interests of monopolies it will be superfluous to ask upon what meat this Cæsar feeds, that he has grown so stout, for they will be furnishing the meat and all the other provisions just as they are now. It is useless to complain to the Cæsar of monopoly—strike at the source of his power.

Some Light in Employing Convicts.

The prison labor bill passed lately by the New York State Assembly, which was introduced by Mr. Graham, a workingman elected to that body last fall, seems on the face of it to be the most sensible and progressive action the Legislature has taken upon this much discussed subject. It requires that the convicts in all the local penitentiaries must hereafter be employed upon roads, streets, farms, stone cutting, or other work required by the county or other local governments. In short, the convicts in local penal institutions must be employed upon local public work. Part of the work is to raise their own provisions and make their own clothing. As prisoners must be employed at some kind of hard labor, this plan seems to offer the least objectionable interference with free labor. It is not an experiment, but a plan well carried out in some European countries as well as here. No private contracts for the labor of convicts are allowed in England, and no proposition to let such contracts would be tolerated. There is a railroad about 34 miles long in the northern part of the State of New York built by the inmates of Dannemora prison. The State wanted the road for use, but soon a pliable Legislature leased the line to a prominent politician for 99 years at $1 a year. His company now runs it. Convicts built the original Sing Sing prison.

There is plenty of public work for convicts near the penitentiaries—work that should be done and is not done. In the Kings County penitentiary in Brooklyn there are a large number of convicts who have been employed for years in manufacturing shoes, to the injury of free labor. The streets of Brooklyn are extremely dirty, and the city will not employ laborers enough to clean a tenth part of them. Let the convicts from the penitentiary be employed in gangs to keep every street clean, and the citizens *en masse* would oppose any proposition to go back to the old contract system. Not a citizen need be discharged who now works on the streets.

One feature of the Graham bill forbids the employment of machinery in the penitentiaries; that is, it takes away the means of manufacturing, so the law cannot well be evaded. Clothing and everything the convicts need to make for their own use can be made by hand. Pounding stone is also good work for the prisoners.

We shall be glad to see the prison labor problem solved on the general plan proposed by Mr. Graham.

We published week before last a communication on "Centers for Wood Turning," by H. K. Porter, the article being accompanied by sketches. Mr. Porter also forwarded to us a specimen of wood turning done on such centers as he described. The piece is 1½ inches diameter at the center, necked down to ⅝ inch at the ends, and is beaded at the corners. It is made up in four equal sections which were held together for turning by the centers. To get the small hole for the center the corners of each piece were cut off at the ends. The centers held the pieces together perfectly, as is clearly shown by the finished product.

Literary Notes.

PRACTICAL ELECTRICITY. A LABORATORY and Lecture Course for First Year Students of Electrical Engineering, based on the Practical Definitions of the Electrical Units. By W. E. Ayrton, F. R. S., Assoc. Mem. Inst. C. E., Professor of Applied Physics at the City and Guilds of London Central Institution. With numerous illustrations. Published by Cassell & Company, 741 Broadway, N. Y.

This is a book of more than 500 pages, and we do not recollect ever to have seen the subjects treated presented so plainly before. The author apparently appreciated that he was writing of a science but little understood, and did not take it for granted that the reader would know very much of the subject. This is fortunate, and makes the book valuable for practical men. We should think it would have an extended sale. The publishers have not favored us with the price.

We have received the first number of the *Technology Quarterly*, published by a board of editors selected from the senior and junior classes of the Massachusetts Institute of Technology, Boston, Mass. It is in magazine form. The following from the introductory will explain what the quarterly is to be:

A large amount of original work is done in the Institute every year by the advanced students which lacks a suitable channel of publication. It is thought by the editors that the *Quarterly* will be an acceptable journal if it contains nothing more than the results of the original investigations made in the chemical, physical, mining, mechanical, and biological laboratories, and also in the departments of civil engineering and architecture. But it is further expected that the alumni of the Institute will be glad of this medium for recording their investigations and the results of their practical work.

The subscription price is two dollars a year.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(253) F. T., New York, writes: Will you give me the measure of ports and bridges, length of valve, lead, lap and throw of an eccentric for an engine which is to have a cylinder 2⅜"x3"? *A.*—Steam ports, 1¼"x⅜"; exhaust port, 1¼"x¾"; bridges, ¼"; lead, 1-64"; lap, 3-16"; length of slide valve, 2⅜"; throw of eccentric, 1¼".

(254) J. R. T., Norwich, Conn., asks: Can you tell me how cores are made with rosin, and are they better than when made with flour? *A.*—The rosin is used instead of the flour, and in about the same proportion. Thomas D. West says in his book, American Foundry Practice: "Rosin is good for cores that are hard to vent, as the gases escape and ignite freer than when flour is used. Rosin cores also will stand the dampness of green sand moulds, and, as a general thing, leave a smoother surface or hole in a casting than flour."

(255) J. G. T., Corvallis, Oregon, writes: 1. Is the link on a locomotive a perfect expansion gear? In other words, can it be hung by the reverse lever so as to cut off the steam at different points of the stroke? *A.*—The link on the locomotive can, is, and must be hung so as to cut off equal portions of steam at different points of the stroke; but because, when the link does cut off steam, the steam ports are not opened as wide as when the link is in full gear, the link motion is not considered to be a perfect one, but at the present time it certainly is the best that can be applied to a locomotive, and it is very doubtful if a better one will ever be invented. 2. Is there any kind of condenser except the surface and jet condenser on ocean steamers? In other words, is there any kind of condenser to condense the salt water? *A.*—We do not know of any other, excepting a comparatively small condenser used for condensing the salt water so as to separate it from the salt, the water being used for various purposes on board the ship.

(256) H. M., Columbus, Ohio, asks: Will you please tell me whether the natural gas which is found in and around Pittsburgh and Tiffin has ever been successfully used for propelling gas engines without first being purified? Also can it be used for illuminating purposes? Also the pressure per square inch? *A.*—In reply to the above, Charles Paine, vice-president and manager of the Philadelphia (natural gas) Company, writes us: "Natural gas is being successfully used in gas engines in Pittsburgh under a system devised by Mr. William Ritchey, of Weyman & Bro., Duquesne Way, Pittsburgh, who has some special arrangements for igniting the gas. It has not been successfully used, so far as we know, outside of these devices. Natural gas is used for illuminating successfully with special burners or by carburetting. The pressure of the gas at the wells is about 500 pounds per square inch; in the city mains about 7 pounds per square inch, and in the house pipes about 3 ounces per square inch."

(257) H. S., Hageman, Ind., asks: 1. How can I find the horse-power of a stationary engine? *A.*—Multiply the area of the cylinder in square inches by the mean effective steam pressure in pounds; again, multiply this product by twice the length of the stroke in feet, multiplied by the number of revolutions per minute, and divide this last product by 33,000, the quotient will be the horse-power imparted by the steam. From this deduct about 15 per cent.; the remainder will be the actual horse-power of the engine. This rule applies only to single-cylinder, high-pressure engines. 2. How can the motion of a stationary engine be reversed, the engine having a slide cut-off valve? *A.*—Change the position of the eccentric which gives motion to the main slide valve. Probably in your case the best method to pursue to change the position of the main eccentric will be to place the engine on a dead center, note the lead, and then move the main eccentric around the axle till it is on the other side of the crank, with the same lead as before; fasten the eccentric in this position. As to the eccentric of the cut-off valve, this may or may not have to be changed, as the position of its eccentric depends on kind of cut-off valve used.

(258) J. H. G., Leadville, Col., writes: 1. We have two ponds; the water is conveyed to one from the creek, and when about full it runs into the other pond through an 8"x10" wooden box. Will a funnel-shaped box cause any more water to flow through it? *A.*—The shape of the box will not make any difference in the amount of water discharged, providing the box is not submerged. 2. We want to transmit 50 horse-power 125 feet over or under three railroad tracks. Which is the best way, to use spur gear and shafting to run under the railroad track, or wire cable to go over the railroad track? *A.*—We prefer the shafting. 3. In either case, how much power will we lose in the transmission? *A.*—From about 3 to 5 per cent.; in any case, it is very difficult to say exactly how much power will be lost by the transmission of a shaft or wire rope, and still more difficult if the data given are insufficient, as in your case. 4. How much will 125 feet shafting, 3⅛ inches in diameter, expand and contract in a temperature varying from 25° below to 90° above freezing point? *A.*—About 5/6 of an inch. 5. Which would be the cheapest, to transmit this power from where we have a surplus, or put up and maintain an independent plant? *A.*—Transmission from the surplus will be the cheapest. 6. Do you think the license law for engineers will prevent boiler explosions? *A.*—Only to some extent; boilers made of bad material, and carrying a greater pressure than they should do, will explode some time or another, which licensed engineers cannot prevent. 7. What is gold bronze made from? *A.*—Gold-colored bronze powder is made of verdigris, 8 ounces; tutty powder, 4 ounces; borax and niter, each 2 ounces; bichloride of mercury, ¼ ounce. These are made into paste with oil, and then fused together. Another way is to grind Dutch foil or pure gold leaf to an impalpable powder. 8. Who is the inventor of the sight-feed cylinder oiler? *A.*—Impossible to say; a number of persons claim to be the inventors. 9. What can I use in cylinders that will stop small sand holes only large enough for oil to work out? *A.*—In our opinion, defective cylinders are not fit to use; throw them away and obtain new ones.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Gear Wheels. See Geo. B. Grant's adv., p. 16.

To Let—Part of large store. 43 Dey st., N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Edw. Sears, Wood Engraver, 169 William st, N. Y.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Air Compressors, Rock Drills. J. Clayton, 43 Dey st., NY

Exhaust Tumbl'g Bbls. Henderson B's., Waterb'y, Ct.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Solid Nickel-Seated "Pop" Safety Valves. Consolidated Safety Valve Co., 111 Liberty st., N. Y.

Robbs' Patent Composition for case-hardening. Send for circular. F. W. Tasney, Paterson, N. J.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Extra capacity, hollow-spindle Hand Lathes; correspondence solicited. J. R. Rand, Brattleboro, Vt.

20", 25", 28" B.G. and S. F. upright drills for immediate delivery. Currier & Snyder, Worcester, Mass.

Ice and Refrigerating Machines. 124 built, and all successful. David Boyle, 521 Monroe St., Chicago, Ill.

Drawing Materials, all kinds. Get catalogue. Mention this paper. G. S. Woolman, 116 Fulton st., N. Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

The Improved Tabor Steam Engine Indicator, made and sold by The Ashcroft Mfg. Co., 111 Liberty st., N. Y.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 92 Park row, N. Y.

Machinists' supplies, brass goods, m'f'rs' supplies, polishing materials, all kinds wire, metals, etc.; in any quantity. Jordan & Gottfried, 208 Canal st., N. Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N. Y. Send for des'n.

Patents, American and Foreign, promptly procured and sold on best terms by Jas. H. Lancaster, patent attorney, 187 Broadway, N. Y., and London.

Small Machine Shop Plant for sale; best of tools up to 50"; building can be rented low. Address Chs. W. Griggs, Dearborn and Monroe sts., Chicago, Ill.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

New Book on Gears; Tables giving 3,094 diameters, with rules for calculation of movements of shafts, etc.; sent on receipt of P. O. Note; price 50 cts. Address C. B. Long, M. E., Worcester, Mass.

Reed's Engineer's Hand-Book to the Local Board Examinations. Eleventh edition revised and enlarged, with 260 diagrams and 36 large plates. 8vo., cloth, $4.50, post-paid. Catalogue of books free. E. & F. N. Spon, 35 Murray st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2 post-paid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

MANUFACTURES.

W. F. Collins will build a broom factory at Bristol, Tenn.

The city of Gainesville is to vote upon the proposition to build water works.

A button factory is being erected by Lincoln A. Case at East Freetown, Mass.

A company has been formed to light the village of Ware, Mass., by electricity.

M. Riodan will build a factory for making japan at 56 Oliver street, Newark, N. J.

The Louisville Southern Railroad Company will build machine shops at Louisville, Ky.

Kaufher & Co., will build a two-story frame factory at 42 to 46 Garden street, Newark, N. J.

The American Paper Box Company will rebuild their factory, recently burned, at Nashville, Tenn.

The Cleveland and Canton Railroad Company will build machine shops, probably at Cleveland, Ohio.

A large furniture factory will probably be built at Owensboro, Ky., by H. L. Damm, now of Stephensport, Ky.

The Texas and Pacific Railroad Company are building a machine shop and round-house at Boyce, La.

The Greenville Water Works Company have contracted to build water works in the city of Greenville, Miss.

Armstrong, Craig & Co., 14 South Sixth street, Philadelphia, Pa., are to build a five-story factory on Levant street.

Carl Hausiet will build a five-story brick factory, 40 x 200 feet, on Thirteenth street, near Third avenue, Brooklyn, N. Y.

The Paterson (N. J.) Iron Works, recently destroyed by fire, will be rebuilt. The works extended over 18 acres of ground.

The Hubbard Tinning Company, Hubbard, Ohio, have succeeded in making tin plate believed to be superior to that imported.

The Taylor Metallic Railway Tie Company has been organized for business at Camden, N. J. E. L. Taylor and others are interested.

The Hewes and Phillips Iron Works, Newark, N. J., have issued a two-leaved pamphlet, illustrating their compound engines.

The largest copper and silver smelting and refining works in the world are to be built at Duluth, Minn. The capital employed will be about $3,000,000.

Work in the way of converting the Washington Navy Yard into a gun factory is in progress. Many new tools and a good deal of heavy machinery will be required.

Folger & Drummond are building a carriage factory at Amesbury, Mass. The building will be 55x172 feet, five stories high, and will have a three-story wing 45x65 feet.

Local papers say that 124 locomotives, 93 passenger cars, and nearly 4,000 freight cars will be built this year at the Altoona shops of the Pennsylvania Railroad.

M. T. Moody is interested in building a foundry, also a coach factory, at Cross Plains, Ala. E. T. Henderson proposes building a sash and blind factory at the same place.

The Mexican Iron Mountain Manufacturing Company, of Durango, Mexico, have contracted for part of a rolling mill outfit, including a 460 horse-power Porter Hamilton engine.

A. Appleton, formerly connected with the Hall's Engineering Company, is opening an office at No. 45 Cortlandt street, New York, to handle injectors and engineers' supplies generally.

The Great Western Manufacturing Company, of Grand Haven, Mich., will erect an extensive factory at that place. There will be seven buildings—one 52x400 feet, one 52x200, one 40x100 feet, one 20x200 feet, and one 40x100 feet.

The Betts Machine Company, Wilmington, Del., have just completed, for the Otis Iron and Steel Company, of Cleveland, Ohio, a lathe for turning 30-inch steel rolls. It is a 66-inch lathe, with 43 ft. shears, and weighs over 100,000 lbs.

A. D. Laws, of Bridgeport, Conn., has formed a connection with the Coulter & McKenzie Machine Company, of that city. The latter firm talk of building a larger factory to accommodate their increasing business. They are now working overtime in some departments.

Ground has been broken at Bridgeport, Conn., on the property fronting Cedar Creek harbor for a new rolling mill. The new factory will have direct railroad connection as well as water facilities, and it is expected the works will be completed and in running order in sixty days.

W. H. Wilhelm & Co., Reading, Pa., write us: "Kindly correct in your paper the item that H. C. Heckendorn succeeded Heckendorn & Wilhelm, as W. H. Wilhelm & Co. succeeded the old firm, and all machinery formerly built by the old firm is still built by us, with the addition of some new machinery recently brought out."

The resolution "that an invitation is hereby extended to any corporation to erect in the city of Macon a complete system of water and gas works; that for the purpose of promoting said enterprise the city of Macon pledges the cordial support to make such undertaking a success," has been passed by the city council.—*Manufacturers' Record.*

The mill agents of Lowell have voted to give the operatives a half holiday on Saturdays, beginning this week. Work will be begun at 6.15 A. M., instead of 6.30 as now, and the mill bells will ring out at 6 o'clock in the evening every day but Saturday, when work will cease at 12.30 P. M. The new arrangement, it is stated, gratifies the hands greatly. —*Boston Journal of Commerce.*

According to the Chicago *Journal of Commerce* the following-named towns in the State of Michigan are either drilling for gas or have wells in operation: Port Huron, Manistee, Grand Rapids, Coldwater, Owosso, Jackson, Adrian, Grand Haven, Wyandotte, Elkhardt, Blissfield, Bronson, Tecumseh, Ypsilanti, Ann Arbor, Howard City, Michigan City, Monticello and Union.

The Woonsocket (R. I.) Electrical Machine and Power Company have purchased the Bernon Mill. This is a large property, and will give the company needed room, and also several rooms which they will let to other manufacturers. The company propose to offer liberal terms to those desirous of starting new industries, and will put up additional buildings if required.

A co-operative machine company has been organized in Dexter, Me., with a capital of $10,000, and the following directors: F. E. Burgess, A. R. Bodge, M. L. Oliver, A. L. Oliver and W. A. Brown. The president and vice-president are the first two mentioned, and the secretary and treasurer is J. B. Haskell. A plant of about $5,000 worth of new machinery will be purchased, and every effort will be made to work up a paying business. It is to be known as the Dexter Machine Company.—*Industrial Journal.*

The Sterling Emery Wheel Company, West Sterling, Mass., has been incorporated under the laws of Massachusetts, to carry on the emery wheel and pottery business, heretofore carried on by M. L. Snow. Capital stock, $40,000. Mr. Snow becomes president of the new company, and L. Best, of New York, will be general manager. The New York office will be in charge of C. Homer Bush, at Nos. 50 and 52 John street.

The citizens of Freeport, Pa., will donate a manufacturing site of five acres, with a house costing $3,000 situated on it, to any company that will build and keep in operation an industry employing 150 men. Or there is a plot of 55 acres that will be donated instead of that named, if it should be preferred. Industries employing a less number of men will receive donations of land in proportion to their magnitude. Any one desirous of hearing further of the advantages of Freeport, and the inducements offered to manufacturers, can do so by addressing J. B. Miller, secretary of the Freeport Improvement Association.

The North St. Louis Car Company have secured leases on considerable property on North Ninth street, upon which to erect works and establish their yards. Between Palm and Harrison streets they will have a frontage on Ninth of 450 feet, counting both sides of the latter, and one of their lots extends through to North Broadway. All told, they have 72,000 square feet of ground, about one-half of which will be covered with buildings. Their main structure will be 60x140 feet, three stories high; the paint shop, 60x150 feet; besides which there will be the blacksmith shop and boiler room, and the office on North Broadway.—*Age of Steel.*

The Yale & Towne Manufacturing Company in 1882 came into possession of all the inventions and patents of Albert H. Emery relating to scales, gauges and testing machines. Those who are acquainted with the principle of these machines will readily understand that there is required in their manufacture a plant with facilities for working pieces of large size and weight with the utmost precision. This the Yale & Towne Company has successfully accomplished, but it is found that the plant required is entirely special with them, the work not harmonizing with the other products of their works. This alone has induced them to transfer to William Sellers & Co. exclusive right to manufacture the Emery testing machine in the United States. With the special tools transferred to them by the Yale & Towne Company, the Messrs. Sellers' plant will be complete for the manufacture of these machines, as the work is substantially of the same class as that they are fitted up for doing.

The Harrison Safety Boiler Works, Germantown Junction, Philadelphia, Pa., are building addition to their works, which will enable them to double their output. Recent orders for boilers have been as follows: Ponemah Mills, Taftville, Conn., five boilers, 866 horse-power, third order; Whittenton Mills, Taunton, Mass., four boilers, 536 horse-power, third order; Sterling Dyeing and Finishing Company, Sterling, Conn., two boilers, 300 horse-power; Tremont Nail Company, Wareham, Mass., two boilers, 250 horse-power, fourth and fifth order; Mather Electric Company, Manchester, Conn., two boilers, 150 horse-power; Perry Stove Company, So. Pittsburgh, Tenn., one boiler, 150 horse-power; Clermont Woolen Mills, New Richmond, O., one boiler, 100 horse-power, second order; A. Williams & Co., So. Woodstock, Conn., one boiler, 65 horse-power; Pearne & Tower, Oxford, N. Y., one boiler, 40 horse-power; A. L. Pennock, Lansdowne, Pa., one boiler, 30 horse-power, fourth order; J. L. Stadelman, Ardmore, Pa., one boiler, 25 horse-power; Provident Life and Trust Company, Philadelphia, Pa., one boiler, 16 horse-power; M. B. Humphreys, Philadelphia, Pa., one boiler, 16 horse-power; W. W. Griscom, Philadelphia, Pa., one boiler, 16 horse-power.

The Buffalo Forge Company, Buffalo, N. Y., write us to say that the impression has gone out that it was one of their forges that got out of order at the recent horseshoe-turning contest at Buffalo. This is not true, the three Buffalo forges working perfectly without a hitch till the close of the contest, which was enthusiastically watched by a large number of people.

Machinists' Supplies and Iron.

NEW YORK, May 26, 1887.

The noticeable feature in manufacture is that there is no accumulation of stock. The demand is steady, and manufacture is kept just at the point of supplying the demand. Those who think trade is moving slowly should take note of this condition as likely to have future influence.

Iron—Sales of American pig are mainly in small lots; there is no tendency to buy heavily, neither are furnacemen inclined to force sales. We quote for standard brands No. 1 X Foundry, $20.50 to $21.50; No. 2 X, $19.50 to $20; Grey Forge, $18 to $18.50.

Scotch Pig—There are some indications that prices of Scotch brands may rule a trifle lower, though this may be prevented by smaller importations; there appears to be a tendency in that direction. We quote: Coltness, $22 to $22.50; Gartsherrie, $21.50 to $22; Summerlee, $21.50 to $22; Eglinton, $20.50 to $21; Dalmellington, $20.50 to $21.

Antimony—Hallett's, 7.75c.; Cookson's, 8.95c.

Copper—There have been but few sales, and prices are nominal, at 10c. for Lake; other brands, 9c. to 9¼c.

Lead—Prices are held fairly firm, at 4.65c. to 4.70c.; several sales of car loads have been made at the first-named price.

Spelter—Refined, 5¾c. to 6c.

Tin—Prices have been quite irregular, in sympathy with the London market. Jobbing lots of Banca have sold at 23½c.; Straits and Malacca, 23.05c.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—A few good competent machinists to set up work in shop. Apply to 115 Liberty st., N. Y.

Wanted—Second-hand engine and boiler about 50 horse-power, modern, and not much used. Address Box 1439, Middletown, N. Y.

A man with theoret. and practical experience wishes situation as designer or foreman of drawing room. Address M. E., AM. MACHINIST.

Wanted—Position to run stationary engine; will go anywhere to get steady work. Address K. J. Dennison, 719 Shehy st., Youngstown, Ohio.

Assistant Draftsman—Situation wanted by a young man in the South; 7 years as machinist; mathematics; references; age 24 years. Address C. R., AM. MACHINIST.

Wanted—A mechanical designer and draftsman in heavy saw mill machinery. Apply, giving references and wages wanted, to The Wm. Hamilton Mfg. Co., Peterborough, Ontario, Canada.

Wanted—Competent draftsman, experienced on general machine shop, blast furnace and rolling mill work; give references and state salary expected. Address Machine Shop, care AM. MACH.

Wanted—Situation by a first-class mechanic, thoroughly acquainted with the manufacture of light hardware, also electrical supplies; 7 years as foreman. Address P. R., Box 43, AM. MACHINIST.

Designs and working drawings prepared for every branch of mechanical engineering; pumping machinery a specialty. A. C. Christensen, 26 Church st., N. Y. (late chief draftsman for Henry R. Worthington).

Wanted—At the Pittsburgh Locomotive Works, Pittsburgh, Pa., foreman patternmaker; must thoroughly understand locomotive work. Address D. A. Wightman, supt., stating age, experience and wages expected.

A first-class machinist and engineer, who has had four years' experience selling machinery and supplies, desires a responsible position with a machinery house, or to represent some first-class specialty in the New York market. Address Engineer, AM. MACHINIST.

Wanted—Situation by a young engineer, A. M. I. C. E., well up in fast steam yacht and launch building, torpedo boat, yacht and launch machinery, drawing office and shops; long experience at a first-class firm in Great Britain. Address A. M. I. C. E., American Exchange, 449 Strand, W. London, England.

In a light, clean, manufacturing business for designing and drafting, and having charge of repairing of machines in use and of making of new machines, a machinist having experience in small and larger work and in designing and drafting; a good, steady place for the right man; only an excellent workman wanted; state age, present position and salary expected. Address George Gardner, 667 Sixth st., Detroit, Mich.

✢ MISCELLANEOUS WANTS. ✢

Advertisements will be inserted under this head at 25 cents per line, each insertion.

Crescent Boiler Tube Expander; second to none, price in reach of all. Crescent Mfg. Co., Cleveland, O.

The Crescent Link Belt Coupling; something new; sample free. Crescent Mfg. Co., Cleveland, O.

Light mach'y of all kinds built at short notice Edmund Mills, 8 Dey st., Jersey City Heights, N. J.

Stationary and boat engines, boilers; best made cheapest price. Washburn Engine Co., Medina, O.

Special tools and machines for mfg. designed and built to order; mechanical and Patent Office drawings. I. A. Weston & Co., Syracuse, N. Y.

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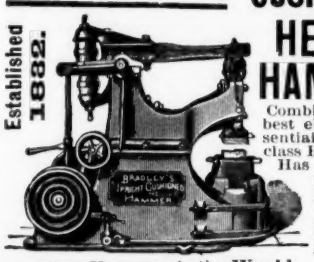

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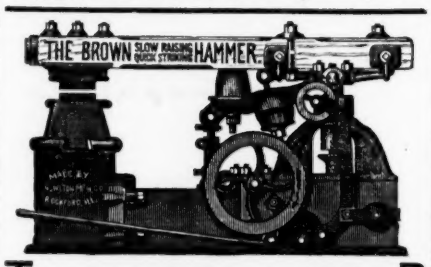

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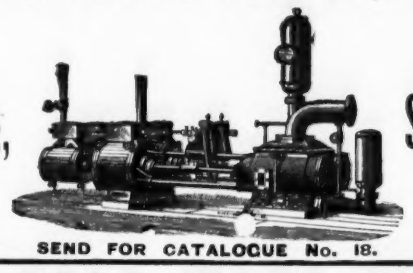

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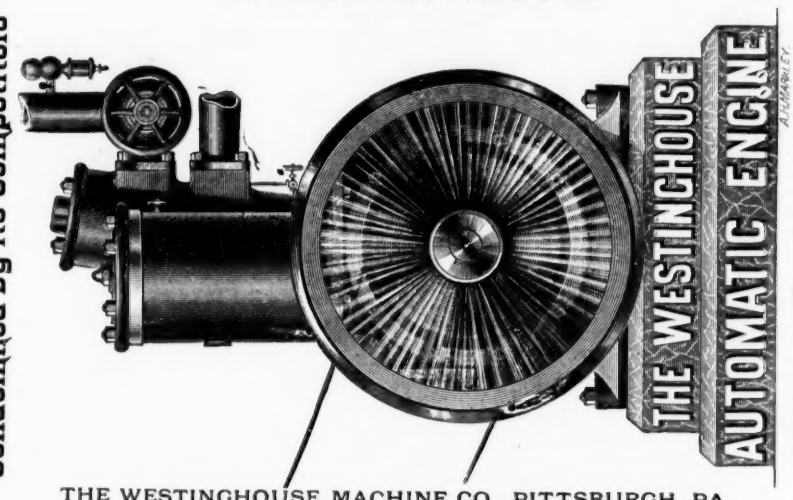

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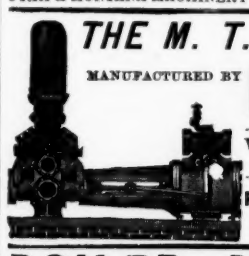

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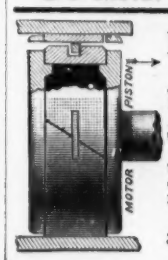

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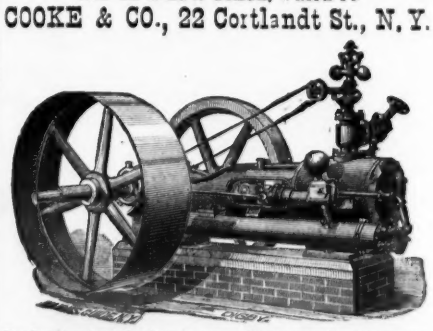

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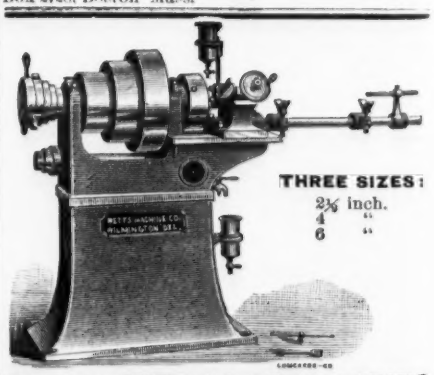

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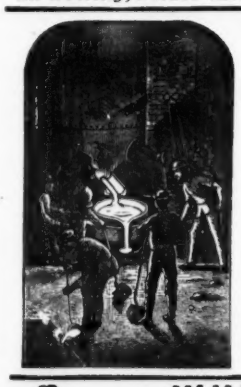

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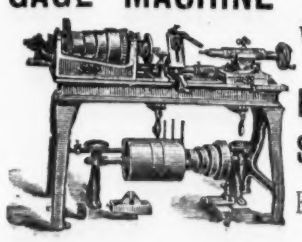

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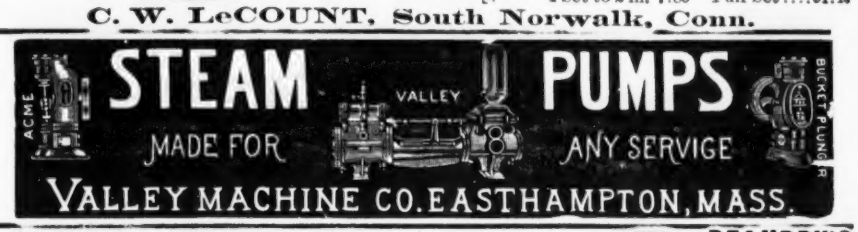

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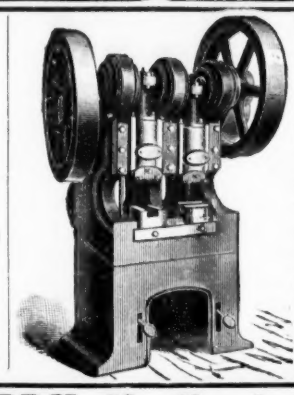

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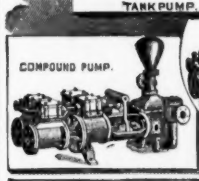

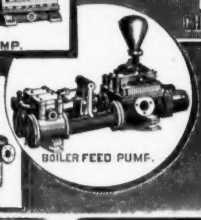

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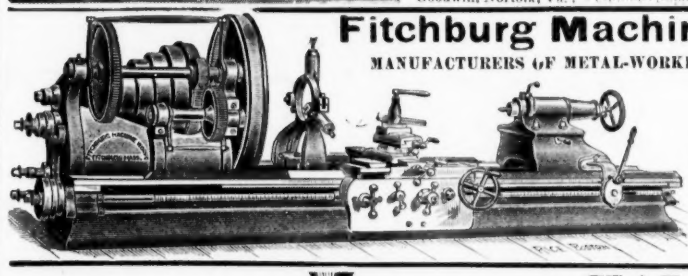

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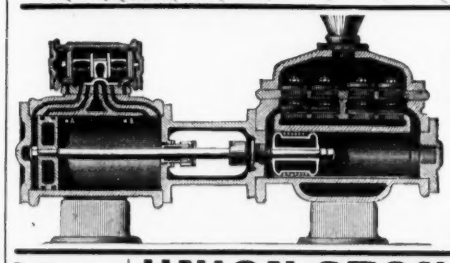

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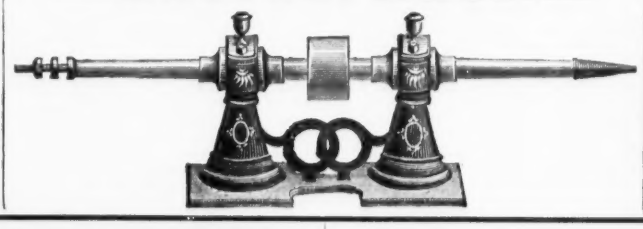

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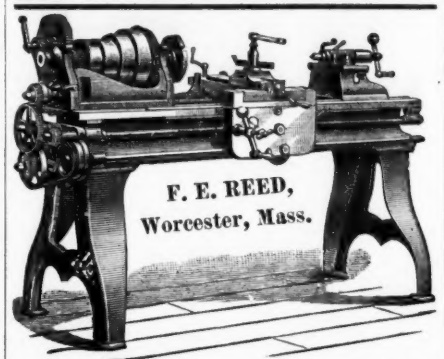

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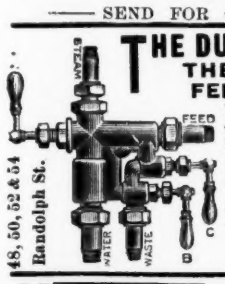

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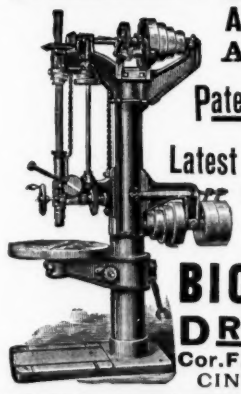

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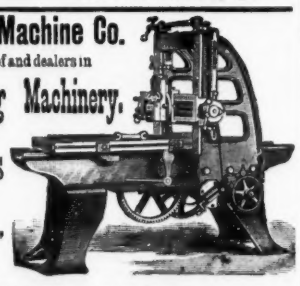

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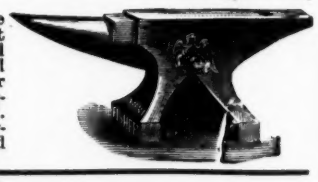

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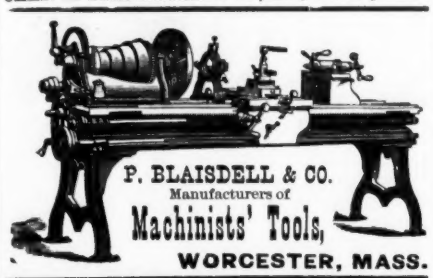

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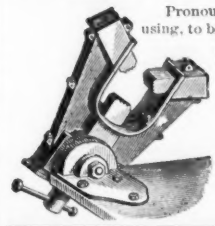

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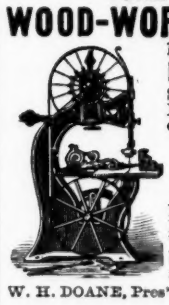

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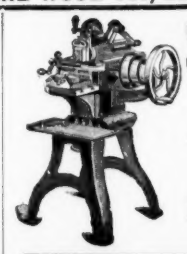

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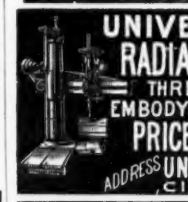

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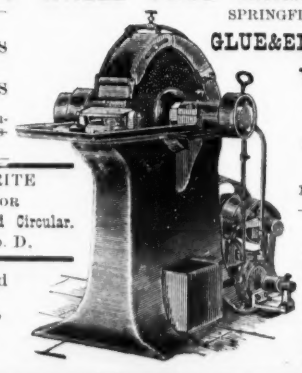

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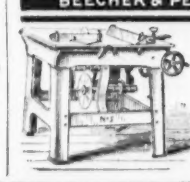

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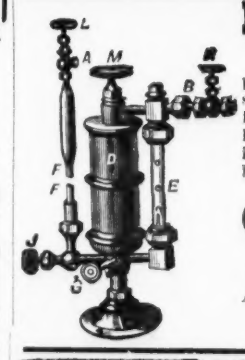

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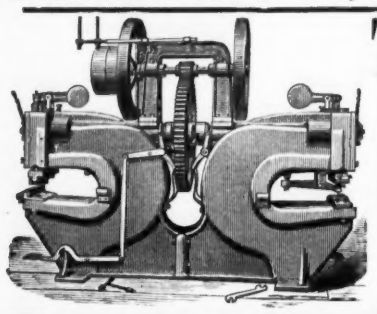

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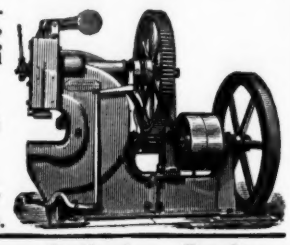

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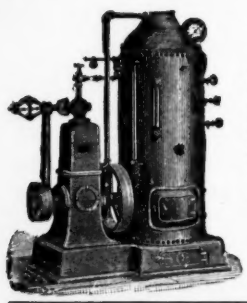

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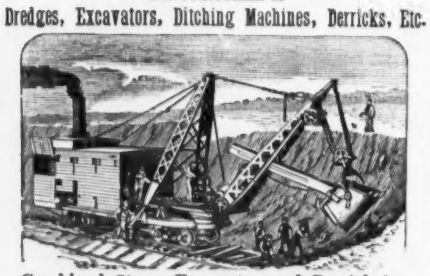

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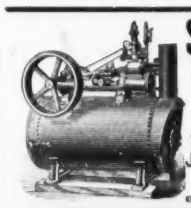

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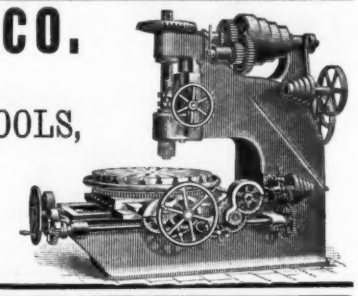

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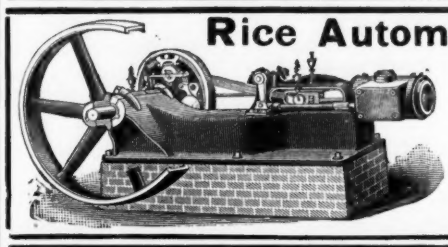

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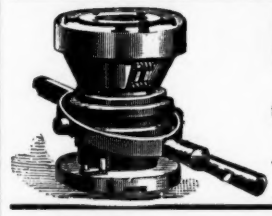

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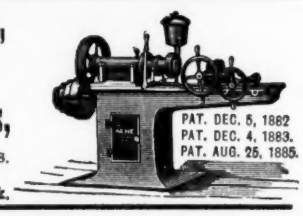

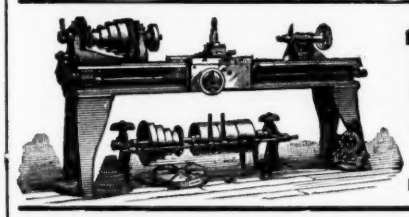

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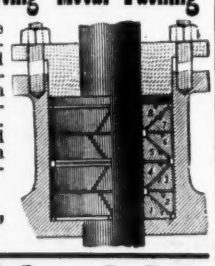

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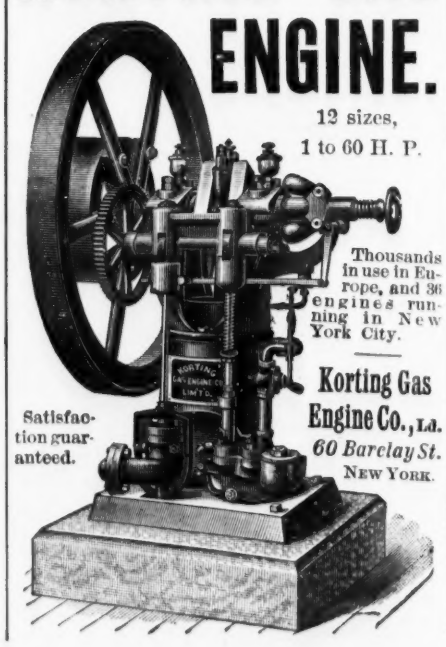

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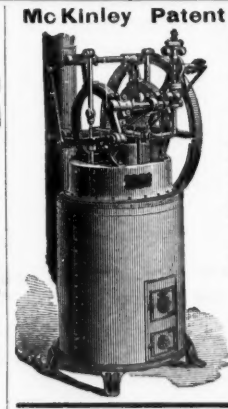

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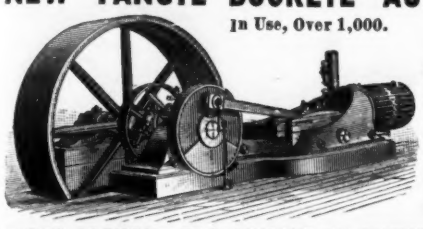

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H.P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

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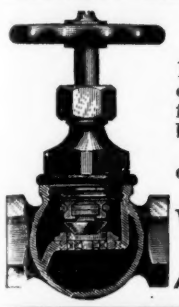

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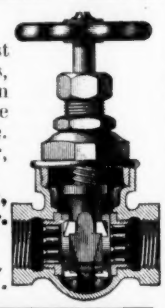

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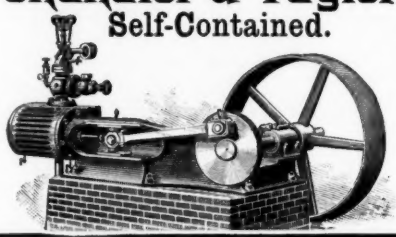

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We make no charge for extras. Every lathe is furnished with *hollow spindle*; the 19" with 1⅛" hole, and 21' with 1⅜" hole. Every lathe has substantial *compound rest*, heavy tool post (bar steel), rest to turn full swing, *following rest* with adjustable jaws to take any size from 2½" down, with extra tool for shafting.

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GUARANTEE.

We guarantee this lathe to be equal in workmanship, truth, accuracy, solidity, material and finish, to the best made, and hold ourselves legally liable for this guarantee.

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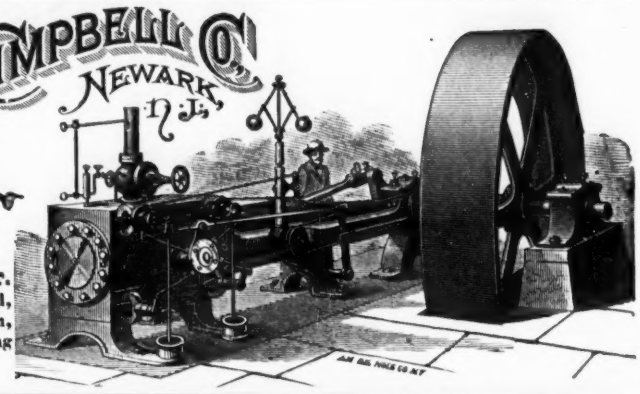

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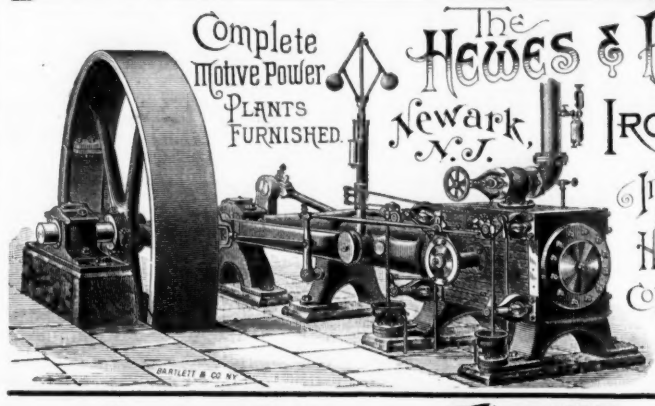

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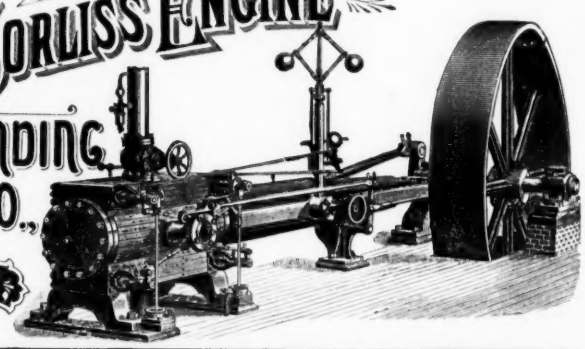

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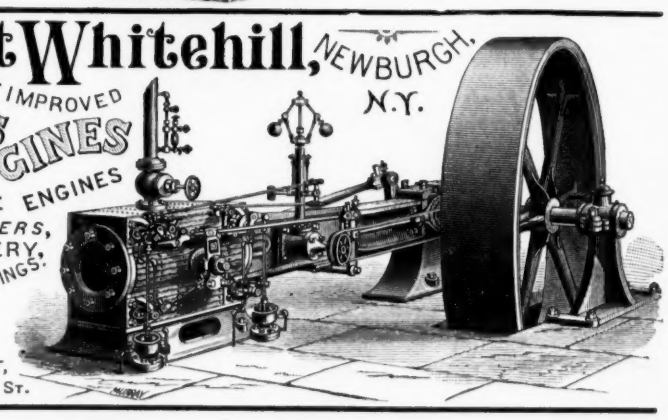

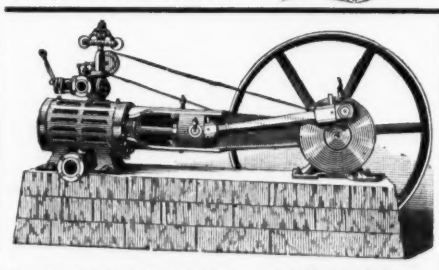

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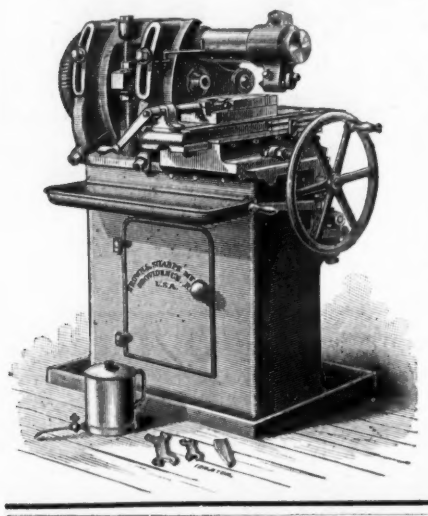

We have in our works and in constant use, about one hundred Milling Machines, and our experience with them has demonstrated that for manufacturing purposes where many duplicate pieces are required, that the best work is produced and the most economical results obtained from machines that are compact and solid, so arranged that the pieces operated upon can be quickly placed in position and quickly removed after the cut is taken.

We have designed a line of Milling Machines for manufacturing purposes, combining the above desirable qualities, of which the No. 3 Plain Milling Machine is a type, and by their use we have found it practicable to produce from 10 to 20 per cent. more work in a given time than we could possibly obtain from any other type of a milling machine on the same work.

The Spindle is driven by a gear and pinion from a three-step cone with 3″ belt. It has a vertical adjustment of 6″.

The Table is 9″ wide, 27″ long, and has 12″ longitudinal and 4½″ transverse movement, and is moved longitudinally 2″ by one turn of the hand-wheel.

The Feed is automatic with three changes, stopping automatically at any required point.

The Vise has jaws 6⅛″ long, 1 7-16″ deep, and will open 3⅜″.

Counter-shaft has pulleys 10″ diam. for 3″ belt, and should run about 375 turns per minute.

The Price includes vise, counter-shaft, wrenches, &c., delivered f. o. b. at Providence, R. I. Weight, 2550 lbs

CAR WHEEL & AXLE MACHINERY.

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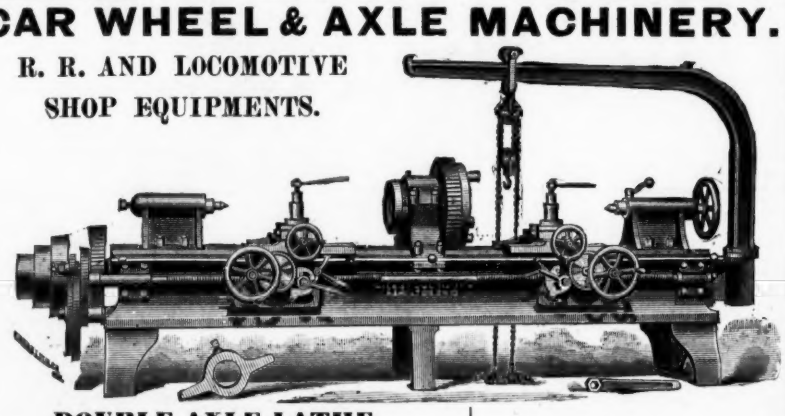

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GRANES

OF ALL TYPES.

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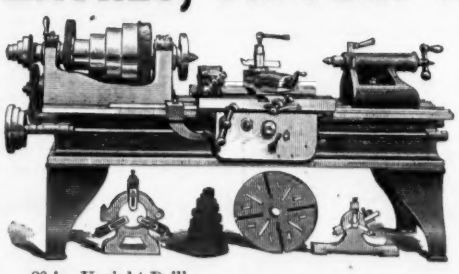
ENGINE LATHES, SHAPERS & DRILLS.

20-INCH LEVER DRILL.



20 in. Upright Drill
24 " " "
26 " Back Geared and
30 " Power Feed
38 " Drills.

26-INCH BACK GEARED AND POWER FEED DRILL.

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Send For Prices. It Will Pay You.

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AUTOMATIC GEAR CUTTER.

18 in. 25 in. 36 in. 50 in. 60 in. 84 in. Sizes.

"Experts pronounced it the best."

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MILLING MACHINES, DRILL PRESSES,

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SEND FOR ONE.

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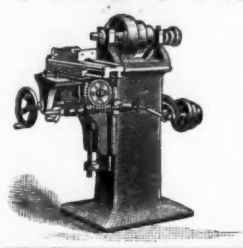

Manufacture Plain Milling Machines, with hand and power feed, of several sizes. Index, double face, vertical face, double spindle and shuttle race Milling Machines. Cam Cutters and Profiling Machines of several kinds. Milling Machines, Vises and Centers. Milling Cutter and Twist Drill Grinding Machines.

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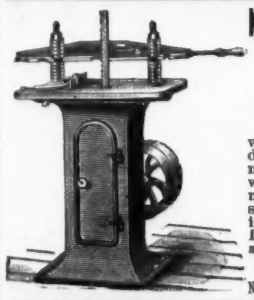

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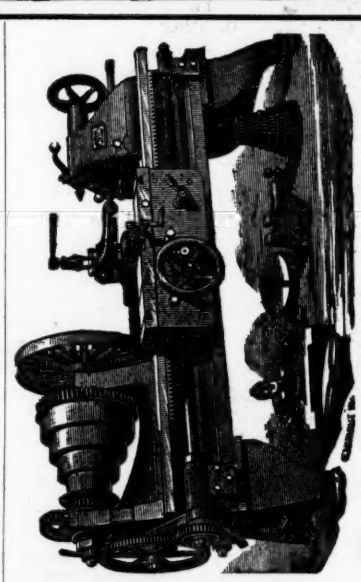

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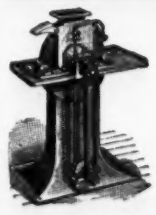

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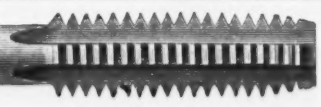

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